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Sport Fishery Abstracts

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Sport Fishery Abstracts

An abstracting service for fishery research and management

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Sport Fishery Abstracts is intended to furnish fishery biologists in government agencies and educational institutions with abstracts of the current literature in sport fishery research and management. Abstracts of papers on limnology, ecology, natural history and other fields of specialization will be included when the subject has application to the conservation of sport fish and the restoration of sport fishing.

The symbol (A) following an abstract indicates an author's abstract. Other initials following the abstract are those of abstractors whose names are listed on the last page. If no symbol is given the abstract was prepared by the Editorial staff. The abstracts are numbered serially through the four numbers of each volume. The numbers will be issued irregularly, with a limit of four per year. Each number contains separate Author and Subject indexes.

The first number of each volume contains a list of publications regularly reviewed for suitable abstracts. The succeeding numbers contain any additional publications covered. Suggestions for additional material are solicited in order to obtain as wide a coverage as possible.

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Robert M. Rutherford, Chief
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Additional Publications Reviewed For Abstracts

Dept. of Nature Conservation Reports, Cape Town, South Africa
Australian Journal of Marine and Freshwater Research
American Microscopical Society
New York Conservation Department of Fisheries Research Bulletins
Institute of Marine Science Bulletins
International Association of Theoretical and Applied Limnology
Journal du Conseil International Pour L'Exploration de la Mer
Transactions of Southeastern Association of Game and Fish Commissioners
Bamidgeh, Bulletin of Fish Culture in Israel

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Editor's Note

Readers who are aware that Dr. William C. Beckman is now with the F.A.O. in Damascus, Syria, may be confused by seeing William R. Beckmann listed as Editor on the preceding page. It happens that there are two fishery biologists named Bill Beckman(n). The present editor has served in a variety of positions, most recently on the Washington staff of the Office of River Basin Studies, Fish and Wildlife Service.

W. R. B.

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315. Milne, D. J. 1955. SELECTIVITY OF TROLLING LURES. Prog. Rpts. of the Pacific Coast Stations, No. 103, July, pp. 3-5.

In contrast to the well-known selection of different sizes of fish by gill-nets, the selectivity of the various types of trolling lures is not clearly understood. In 1953 during a study of spring and coho salmon in the ocean feeding areas off the south-west coast of Vancouver Island, information was collected on the size and species of fish caught by a few types of trolling lures commonly used in commercial salmon fishing. From June 29 to August 2, large and small brass spoons and large and small plastic plugs were fished at various depths. This was accomplished from a chartered trolling boat by having four lures of the same type spaced 5 fathoms apart on each of four separate lines. A total of 54 coho and 97 spring salmon was caught in this manner.

The coho salmon were taken at depths varying from 5 to 10 fathoms (most at 5) while the spring salmon were taken at depths between 10 and 15 fathoms (most at 15). There was no marked difference in either species in the length of fish that was caught at different depths.

In the case of coho salmon, the spoons were much superior to the plugs and in each type the smaller lure was preferred. The length of fish was not markedly selected by the different lures and the percentages of the total catch by number and by estimated weight did not differ much for each type of lure. In spring salmon, the spoons also caught more fish than the plugs, but the larger lure was preferred in each type. The spring salmon varied in both age and maturity and the fork lengths ranged from 35 to 92 cm. (13.8 to 36.2 in.). It is apparent from the differences in the average lengths that the size of fish was selected by the size and type of lure. Thus the large spoon caught both more and larger fish than the small spoon and the large plug caught both more and larger fish than the small plug. The large plug caught the greatest percentage by weight, even though more fish were caught by both sizes of spoons. This was possible because the large plug caught mainly large fish with only 10 percent of them less than 26 in. (total length), while the spoons captured a higher proportion of small fish. The examination of stomach contents revealed that the larger spring salmon were eating more fish than the smaller salmon. For example, 61 percent of the stomachs from spring salmon over 26 in. (total length) contained fish, while only 33 percent of the stomachs from smaller salmon had fish in them. Herring was the dominant food in the stomachs of the spring salmon. The size of the herring consumed ranged from 150 to 190 mm. (5.9 to 7.5 in.) in standard length. Since this is the same length as the 6- and 7-inch plugs commonly used as lures, vision must play an important role in both feeding and troll fishing. In this connection the colour of the lure is an important factor which was not tested in this experiment. For some reason, probably size of mouth, the spring salmon were restricted to eating only the smaller herring which would have been recruited to the herring fishery in the following two winters. Therefore, it appears that the heavy winter fishery on large herring does not directly affect the food supply of spring salmon in this area.

316. Marzolf, Richard C. 1955. USE OF PECTORAL SPINES AND VERTEBRAE FOR DETERMINING AGE AND RATE OF GROWTH OF THE CHANNEL CATFISH. Jrnl. of Wildlife Mgt., Vol. 19, No. 2, April, pp. 243-249.

Vertebrae and pectoral spines were used in a study of the age and growth of 661 channel catfish taken from the Niangua Arm of the Lake of the Ozarks.

Each structure contained annular marks which were shown to be true year marks by the usual tests of validity. This was further substantiated through the study of the same structures from 161 channel catfish of known age. From the standpoint of collection, preparation, and reading, pectoral spine sections were preferred over the vertebrae as they required the least expenditure of time and effort in preparation and were more reliable for age determination because they showed fewer false marks. Deterioration of tissue around the spine lumen obscured part of the first annual mark in older fish. This did not prevent aging but did make the measurement of the first year growth less accurate.

The relationship of body length to spine radius appeared to be curvilinear. The relationship of body length to vertebral radius was best described as two straight lines.

Growth data derived from vertebral measurements was thought to be the better approximation of growth history for the following reasons: (1) growth was more uniform and in better agreement with the empirical data; (2) the spine method, as used in this study, had an unavoidable error that caused calculated lengths to be too short.

317. Martin, N. V. 1955. LIMNOLOGICAL AND BIOLOGICAL OBSERVATIONS IN THE REGION OF THE UNGAVA OR CHUBB CRATER, PROVINCE OF QUEBEC. Jrnl. of the Fisheries Res. Bd. of Canada, Vol. 12, No. 4, July, pp. 487-498.

Ungava Crater Lake, at 73° 41' W.L. and 61° 17' N.L., lies in a meteoritic crater of the northern Quebec tundra. The lake is nearly circular, 1.7 miles in diameter, with steep walls and a maximum known depth of 825 feet. Secchi disc transparency was 35 metres. Summer surface temperatures were 3-4° C., of the deep water a little less. Surface oxygen was abundant, pH was 6.5-6.6. Total solids in the water were less than 20 parts per million, and hardness was only 1.7 p.p.m. Three kinds of mammals and 14 of birds were found in the crater region. Arctic char, Salvelinus alpinus, were the only fish taken in the crater lake. Specimens up to 21.8 inches fork length and 18 years old were taken; they fed on insects and other char. Char in other nearby waters grew somewhat faster but ate the same foods; mature females as small as 4.0 inches were seen. Lake trout, Salvelinus namaycush, in a lake near the crater

reached 33.5 inches and 15.8 pounds. Growth was very slow, the greatest age determined being 21 years, at 13 pounds. Twenty-nine species of vascular plants were collected close to the crater. (A)

318. Godfrey, H. 1955. ON THE ECOLOGY OF SKEENA RIVER WHITEFISHES, COREGONUS AND PROSOPIUM. Jrnl. Fisheries Res. Bd. of Canada, Vol. 12, No. 4, July, pp. 499-542.

Incidental information on the ecology of the common (Eastern) whitefish, Coregonus clupeaformis, and the Rocky Mountain whitefish, Prosopium williamsoni, was collected in the course of the Skeena River Salmon Investigation of 1944-1948. The common whitefish has been found in only four Skeena lakes, which have characteristics that are mainly oliogotrophic. Rocky Mountain whitefish were taken in all the lakes where netting was done, which included warm and shallow, as well as deep and cold, bodies of water. The bottom fauna of Lakelse, Babine and Morrison Lakes was described. During the summer common whitefish were most abundant in depths of 10-15 m., and Rocky Mountain whitefish at 5-10 m. The food of the two species was very similar, and consisted mostly of bottom organisms. An exception was that of common whitefish in Morrison Lake, which had fed almost wholly upon plankton crustaceans. This situation was associated with the paucity of bottom fauna in the lake. The important competitors for food of the whitefishes, identified on the basis of common food and habitat, were peamouth chub, Mylocheilus caurinum, and squawfish, Ptychocheilus oregonense. Chief predators of the whitefish were lake trout, Cristivomer namaycush, and ling, Lota lota. However, there was no evidence that predation upon either whitefish was particularly serious. The oldest common whitefish were 10 years of age (473 mm. fork length), and Rocky Mountain whitefish 9 years (365 mm. fork length). No food organisms occur in the Skeena lakes in such abundance as do certain amphipods in other Canadian lakes where the common whitefish is fished commercially. This scarcity of suitable food is considered to be the main condition limiting the abundance of the Skeena populations of common whitefish. (A)

319. Carlander, Kenneth D. 1955. THE STANDING CROP OF FISH IN LAKES. Jrnl. of the Fisheries Res. Bd. of Canada, Vol. 12, No. 4, July, pp. 543-570.

To determine whether certain environmental factors may affect standing crop, an analysis was made, primarily by regression methods, of the published estimates of standing crops of fish in lakes and ponds. Standing crop estimates derived by draining and those by poisoning appear to be equally accurate, but marking and recovery estimates may not be directly comparable with the other two. Average standing crops in river backwaters and oxbows were almost 500 pounds per acre; in midwestern reservoirs, almost 400 pounds per acre; in other reservoirs and ponds, 200 to 300; in warm water lakes, 125 to 150; and in trout lakes, less than 50 pounds per acre.

No correlation could be shown between areas of lakes or ponds and their standing crops per acre. There was a tendency for standing crop per acre to decrease with increase in maximum depth of trout lakes, of warm water lakes, and probably of reservoirs. Significant increase in standing crop per acre with increase in carbonate content of the water was found in trout lakes, warm water lakes and midwestern reservoirs.

Elton's pyramid of numbers was demonstrated in an analysis of standing crop per acre by species. Competition between species at the same food level may be mitigated by habitat segregation. Standing crop per acre increases as the number of species increases or as the niches are filled. However, standing crops of given species were usually highest when only one or two species were present. Regressions of the standing crops of one species upon those of other species may give clues as to the degree of competition or of protocooperation, but these clues must be critically evaluated since the regressions may be due to factors other than the presence of the other species. (A)

320. Hayes, F. R. and D. A. Livingstone. 1955. THE TROUT POPULATION OF A NOVA SCOTIA LAKE AS AFFECTED BY HABITABLE WATER, POISONING OF THE SHALLOWS AND STOCKING. Jrnl. of the Fisheries Res. Bd. of Canada, Vol. 12, No. 4, July, pp. 618-635.

A stocking, partial-poisoning and creel census experiment was carried out on a stratified lake in an effort to increase the crop of speckled trout, Salvelinus fontinalis. Except for a single year in which adult trout were planted, a negligible proportion of the introduced trout was recaptured. Application annually for five years of about one-half part per million of derris dust to the three-meter zone of the lake during summer stratification produced a heavy kill of coarse fish without harming the trout. Shiner, Notemigonus crysoleucas, perch, Perca flavescens and chub, Semotilus atromaculatus were eliminated from the lake. Sucker, Catostomus commersoni, was drastically reduced. Killifish, Fundulus diaphanus, and eel, Anguilla bostoniensis, were not appreciably reduced, despite large annual kills. Smelt, Osmerus mordax, stickleback, Gasterosteus aculeatus, and trout, Salvelinus fontinalis, were killed in very small numbers during one or more poisoning years.

Three independent estimates of the effect of the experiment upon the trout production of the lake are put forward: (a) The decrease in mass of the fish competing with trout for food, when calculated from the annual kills, amounts to 40 kg. The pre-poisoning mass of trout was 85 kg., calculated from a capture-recapture census. Thus, if trout replaced its competitors quantitatively, the standing crop of trout would be increased to 150 percent. (b) The volume-time of water (i.e. percentage of the lake volume multiplied by the fraction of a year) which would be made available to trout by removing competitors from the part of the lake where summer temperature conditions would limit trout to between 50 and 100 percent of their full activity is

calculated. If trout occupied this volume-time at the same density as they did the more favourable water, the standing crop of trout would be increased to 240 percent. (c) The total yield of the lake to anglers showed a steady increase following poisoning, to about 230 percent of the control value, or from less than one pound per acre to nearly two pounds per acre. These three estimates agree very well, considering the errors inherent in the method. (A)

321. MacKinnon, D. and J. R. Brett. 1955. SOME OBSERVATIONS ON THE MOVEMENT OF PACIFIC SALMON FRY THROUGH A SMALL IMPOUNDED WATER BASIN. Jrnl. Fisheries Res. Bd. of Canada, Vol. 12, No. 3, May, pp. 362-368.

A small-scale field experiment was conducted to investigate the migration of Pacific salmon fry through an impounded water basin, 2.4 acres in area. Pink, chum, coho, spring and sockeye fry were released at the upstream end. During nine days of operating a trap placed below the outlet dam, only pink and chum fry appeared. One-quarter of the total of these latter species moved through the impoundment and were recaptured. The migration of the fry was mainly confined to a period 1 1/2 hours after sunset to 1 1/2 hours before sunrise. The rate of migration of fry through the impoundment differed significantly from the movement of floats also released above the basin. (A)

322. Neave, Ferris. 1955. NOTES ON THE SEAWARD MIGRATION OF PINK AND CHUM SALMON FRY. Jrnl. Fisheries Res. Bd. of Canada, Vol. 12, No. 3, May, pp. 369-374.

The seaward migration of pink and chum salmon fry takes place at night. Strong light is avoided. In pink salmon negative rheotaxis (swimming with a current) is strongly developed and migration is not primarily effected by random swimming and passive displacement. Down-stream movement is mainly at or close to the surface. In slack water vertical distribution is more uniform. In the shortest streams examined, each night's migrants appeared to reach the sea before daybreak. In a longer stream, fry were seen to bury themselves at the onset of daylight. After being held in fresh water for an undetermined period, fry show positive rheotaxis and schooling behaviour and no longer avoid light. Behaviour of fry after reaching the sea also differs from that shown during actual migration. Changes in behaviour may coincide with commencement of feeding. (A)

323. McLellan, H. J. 1955. CHANGE IN BOTTOM TEMPERATURES ON THE SCOTIAN SHELF. Jrnl. of the Fisheries Res. Bd. of Canada, Vol. 12, No. 3, May, pp. 375-386.

A comparison of recent bottom temperatures on the Scotian Shelf with those observed in the period 1934 to 1939 shows that, in general, these temperatures have been higher by from one to three Centigrade degrees in the more recent period. The change has been due to the variation in the intermediate layer which was both colder and of greater thickness during the early period. (A)

324. Shepard, M. P. 1955. RESISTANCE AND TOLERANCE OF YOUNG SPECKLED TROUT (SALVELINUS FONTINALIS) TO OXYGEN LACK, WITH SPECIAL REFERENCE TO LOW OXYGEN ACCLIMATION. Jrnl. of the Fisheries Res. Bd. of Canada, Vol. 12, No. 3, May, pp. 387-446.

Samples of trout were exposed to flows of water containing constant low concentrations of oxygen (produced by equilibrating aerated water with nitrogen). At 9°–10° C. minimum tolerance levels were defined by determining the lowest oxygen level permitting survival of 5 percent, 50 percent and 95 percent of the fish for a period of 5,000 minutes. Median resistance times for samples of fish exposed to lethal levels of oxygen were also determined. Within their first year, most trout reared in aerated water could withstand oxygen concentrations down to 1.9 mg. O_2/l. The 50 percent tolerance level was 1.75 mg. O_2/l. Most fish died at 1.5 mg. O_2/l. Acclimation to low (but not lethal) oxygen levels occurred; for a drop of 1.0 mg. O_2/l. in environmental oxygen concentration, the tolerance level decreased by approximately 0.09 mg. O_2/l. and resistance times at given lethal levels increased up to five-fold. By acclimations trout could exist at 1.05 mg. O_2/l. without direct lethal effects occurring. Between 20 and 33 hours were required for the fish to acclimate to a change of 1.0 mg. per liter in the oxygen concentration of the environment. Acclimation to low levels of oxygen was accompanied by an apparent increase in the ability of the animals to remove oxygen at low environmental oxygen concentrations, suggesting a physiological mechanism similar to that involved in acclimation of mammals to low oxygen. The tolerance levels of small fish were similar to those of large fish at similar acclimation levels, but small fish died more quickly than large fish when exposed to lethal concentrations. (A)

325. Parker, Richard A. 1955. A METHOD FOR REMOVING THE EFFECT OF RECRUITMENT ON PETERSEN-TYPE POPULATION ESTIMATES. Jrnl. of the Fisheries Res. Bd. of Canada, Vol. 12, No. 3, May, pp. 447-450.

A regression analysis, which is based on time changes in the ratio of the number of marked fish in the daily catch to the total daily catch, was used to estimate initial population size. This method eliminates overestimation caused by recruitment. (A)

326. Smith, M. W. 1955. FERTILIZATION AND PREDATOR CONTROL TO IMPROVE TROUT ANGLING IN NATURAL LAKES. Jrnl. of the Fisheries Res. Bd. of Canada, Vol. 12, No. 2, March, pp. 210-237.

A significantly faster growth rate by native and planted eastern brook trout followed the addition of commercial fertilizers in sufficient quantities to provide potential additional concentrations of 0.39 mg. P, 0.21 mg. N and 0.27 mg. K per litre in Crecy Lake (20.4 ha.; mean depth, 2.4), New

Brunswick. Largely because trout planted as fingerlings attained suitable angling size when yearlings, the rate of capture and the yield by weight to anglers approximately doubled. The improved growth rate, but not yields, persisted into the second and third years after fertilization. Coincident was an increase in predation by fish-eating birds and mammals. With predator control and the same stocking rates, the yield of trout flesh produced in the lake increased from 0.9 to 5.9 kgm. per hectare over the next two-year period. With predator control extended to trapping eels in the lake, a second comparable fertilization with respect to concentrations of P, N and K, and a doubling of the stocking rate, a yield of 9.7 kgm. per hectare was realized. The growth rate was somewhat depressed with the heavier stocking, notwithstanding a second fertilization. Facilities for natural reproduction were poor and planted trout (fingerlings and yearlings) sustained the fishery. Maximum survivals of planted trout (all marked) to anglers' catches were 20 percent for fingerlings and 88 percent for yearlings. Cropping of trout of age II was thorough. For the most part, movements of planted trout (trapped in outlet) from the lake would have occasioned minor losses.

Neighbouring Gibson Lake (24.0 ha.; mean depth, 4.0 m.) was fertilized with one-half of the concentrations of P, N and K applied to Crecy. Stocking with trout was at comparable rates but no predator control was exercised. Little improvement was noted in the growth of the trout. Only when yearlings were planted late in the fall and angled early in the spring was there any improvement in the anglers' catches. (A)

327. Forrester, C. R. and K. S. Ketchen. 1955. THE RESISTANCE TO SALT WATER CORROSION OF VARIOUS TYPES OF METAL WIRE USED IN THE TAGGING OF FLATFISH. Jrnl. of the Fisheries Res. Bd. of Canada, Vol. 12, No. 1, January, pp. 134-142.

Observations on the metal used as pins for Petersen-type tags on Parophrys vetulus showed manufactured nickel pins to be most subject to corrosion or wear, with pins of silver wire, nickel and stainless steel wire successively less liable. Tagging wounds were worst with nickel pins and least with stainless steel wire. A correction factor of approximately 1.7 for each year the tag is out is necessary to bring results with nickel pins on a par with those of stainless steel wire. (A)

328. Cook, Eugene. 1954. PARASITES OF SOME COLORADO WARM-WATER FISHES. A publ. of the State of Colo. Dept. of Game and Fish, 71 pp., mimeo.

Parasitic examinations were made of 2,948 fish from four northeastern Colorado reservoirs. It was found that 267, or 9.0 percent, were infected with eight species of parasites.

Three species of external parasites were found on five species of fish. A monogenetic fluke, Octomacrum lanceatum, was found attached to the gills of the western longnose sucker. The parasitic copepod, Lernaea carassii, attached to the fins and body surface of black crappie, carp, and northern fathead minnows. As many as seven of the parasites were found in the tissue of one fathead minnow. A common parasite of the northern black bullheads was the leech.

Piscicola punctata. Three species of roundworms and two species of tapeworms were found in five species of fish. The larval roundworm, Contracaecum spiculigerum, was encysted in the omentum of northern largemouth bass, black crappie, and northern black bullheads. Yellow perch and black crappie harbored the roundworm Camallanus oxycephalus. The adult worms were found protruding from the anus up until time of fish spawning, but were found as larvae in the stomach, pyloric caeca, and intestine following spawning. A fairly common roundworm, Philometra cylindracea, occurred during late spring and early summer in the body cavity of western white suckers. After the middle of July, Philometra cylindracea was not found. Ligula intestinalis, a common larval tapeworm, was present in the body cavity of western white suckers and yellow perch. The higher percentage of infection occurred in western white suckers. Suckers also were infected with the adult tapeworm, Biacetabulum infrequens. Only two fish were infected.

On the basis of this study it is recommended that: (1) live fish to be brought into hatcheries for food be carefully examined for dangerous parasites; (2) parasite examinations should be made periodically in hatcheries to insure that parasitized fish will not be distributed to other water within the state; (3) continued investigations or special attention on surveys be made to study further effects of the parasites or the presence of others.

Proper methods to be used in the preservation of parasites is included for the benefit of field personnel. A key to the major groups of parasites and descriptions of those found in the study are presented to aid in identification of parasites during surveys. A list of fish hosts and their parasites was compiled from references involving studies in various regions of the United States. The list of hosts includes 18 species of the important game fish and other common fishes of the warm-water reservoirs of Colorado. (A)

329. Finnell, Joe C. and Robert M. Jenkins. 1954. GROWTH OF CHANNEL CATFISH IN OKLAHOMA WATERS: 1954 REVISION. Okla. Fisheries Res. Lab. Rpt. No. 41, September, 37 pp. multilith.

Spines from 7,717 channel catfish from 107 bodies of water, captured by various means during the period 1946-1954, were employed in determining average rates of growth of this species under various environmental conditions in Oklahoma. Of the total number of fish, 97 percent were less than 8 years old. Growth was calculated to each annulus, and all averages presented are based on grand average (weighted) calculated total lengths at the end of each year of life from each body of water. Fish collected between November and time of annulus formation (April-May) were considered as having

completed another year's growth.

Channel catfish averaged 4.0 inches in total length at the end of the first year of life and during successive years averaged 8.5, 11.9, 14.5, 16.1, 17.8, 19.9, 21.9, 23.9, 24.8, 25.4, 25.5, 25.8 and 28.8 inches. The length-weight relationship of the channel catfish is expressed by the equation log W= 5.3846+3.4069 log L (total length). Time of annulus formation of channel catfish appears to center in a period from the last week of April to the last week of May, approximately the period indicated for Oklahoma white crappie and largemouth bass, but overlapping both. Comparison of growth of Oklahoma channel catfish with that of channel catfish in other states was not possible since no comparable study has been done elsewhere. Average growth in Oklahoma streams was slightly greater than that in the Upper Mississippi River, at least for the first seven years. In Oklahoma impoundments of various sizes, channel catfish grew faster in small lakes than any other size category. The slowest growth was in old reservoirs and large lakes.

Other environmental factors, including age, turbidity, and extent of successful reproduction, appeared to influence rate of growth more than the water area. Growth-rates were much faster in waters impounded less than four years than in older waters. The majority of poor-growing catfish populations were found in turbid waters with high populations. However, above average growth for each year group occurred in only 2 clear lakes over 110 acres and more than four years old. Clear ponds and small lakes with very limited populations exhibited above average growth. Channel catfish were widely distributed in both clear and turbid waters, although better rates of growth were attained in clear waters. Channel catfish management techniques are discussed briefly.

330. Sprugel, George, Jr. 1955. THE GROWTH OF GREEN SUNFISH (LEPOMIS CYANELLUS) IN LITTLE WALL LAKE, IOWA. Iowa State College Jrnl. of Science, Vol. 29, No. 4, May 15, pp. 707-719.

A study of the growth characteristics of green sunfish in Little Wall Lake, Iowa, was initiated in 1948 with further collections of specimens being made through early 1950. This shallow prairie lake developed winterkill conditions in the winters of early 1949 and 1950. Observations supporting the validity of the scale method for use in determining age and growth of Little Wall Lake green sunfish are given. The mathematical relationship between standard body length (L) and the anterior radius (S) of the magnified (42X) scale was described better by a curvilinear regression than by a linear regression line, but the increase in accuracy resulting from curvilinear correction of the body-scale relationship was not of sufficient magnitude to warrant use of the curvilinear regression formula in routine practical growth studies of green sunfish. Factors for converting standard to total body lengths are given.

Individuals of the 1946 (dominant) year-class grew at a relatively lower average rate prior to the winterkill than did those fish in other year-classes, but the winterkill survivors grew at an accelerated rate in 1949. There was some suggestion from the data that slower growing green sunfish were possibly better able to withstand limited winterkill conditions than rapidly growing individuals. False annuli were found on the scales of many specimens but their development could not be consistently attributed to any one causative condition.

The mathematical relationship between the standard body length (L) in millimeters and the weight (W) in grams for all data combined was found to be adequately expressed by the equation:

Log W=4.76800+3.16876 Log L

Coefficients of condition (K) in green sunfish increased irregularly with increase in length.

331. Johnson, Fritz H. 1955. RAINBOW TROUT MORTALITY AND CARRYING CAPACITY OF A REHABILITATED TROUT LAKE IN MINNESOTA. The Progressive Fish-Culturist, Vol. 17, No. 3, July, pp. 129-131.

The present program for the rehabilitation of small lakes in northern Minnesota for trout has shown the need for information on carrying capacity of such waters, mortality of trout planted in them, and most suitable stocking rates. The present investigation deals with the fish population of a typical lake that was rehabilitated by means of rotenone poisoning in 1949.

Surprise Lake is a small landlocked lake near Grand Rapids, in the northern part of Minnesota. The lake has an area of 11 acres, a maximum depth of 27 feet, and a thermocline late in summer at a depth of 8 feet, below which there is insufficient oxygen for trout. About 30 percent of the bottom area of the lake lies above the thermocline level. The water is soft (total alkalinity, 15.0 parts per million), brown, and of moderate fertility. There are few aquatic plants. Recorded summer temperatures of the surface water range from 74° to 87° F. and in the thermocline (at 10 feet) from 63° to 74° F.

In the summer of 1949 the lake was poisoned with rotenone after a sample of the fish had been marked for determination of percentage recovery. The total fish population was estimated at 77 pounds per acre, mostly of suckers, perch, golden shiners and mud minnows. In the spring of 1950 the lake was stocked at the rate of 136 trout, or 22.7 pounds of trout to the acre. In the spring of each of the following years, the lake has been planted with rainbow trout in amounts ranging from 63 to 161 fish, or 4.3 to 17 pounds of fish, per acre. Size of fish stocked has ranged from 6 to 32 to the pound. No natural reproduction of trout is known to occur in the lake.

Late in the summer of 1954 (August 16 through September 27), after sport fishing on the lake had ceased, the lake was intensively netted. In accordance with the statistical methods of Schnable (1938) and Schumacher and Eschmeyer (1943), estimates of total size of the population of catchable trout were made. By the method of Schnabel, the total population in the lake was calculated to be 88 fish. To

this estimate should be added the 22 fish removed for study, making a total of 110 fish. By the method of Schumacher and Eschmeyer the total population was estimated to be 105 fish plus or minus 19. The trout population per acre was estimated at about 10 catchable-size fish weighing about 3.4 pounds.

Assuming that the 62 trout taken by netting and later aged were a fair cross section of the total population structure, it is estimated that, of the fish in the lake in the fall of 1954, 72 percent had been planted in the spring of 1954, 26 percent in the spring of 1953, and 2 percent in the spring of 1952. Total mortality for these respective year classes from stocking to the time of netting in the fall of 1954 is estimated at 88.3, 98.3, and 99.8 percent, respectively. As there was no creel census on this lake, differential causes of mortality cannot be assigned. Also, nine snapping turtles weighing about 80 pounds were taken during the netting. Such turtles are known to be fish eaters (Lagler 1945); whether they take trout is uncertain.

Scale samples and length measurements show that the growth of the trout in Surprise Lake has been rapid. To check the feeding habits of the trout, the stomachs of 9 trout taken in the nets were examined. Percentages of different foods by volume, were found to be: insects (mostly Odonata nymphs, Chironomus larvae, and Trichoptera adults), 59.4 percent; small minnows, 27.0 percent; detritus and vegetation, 10.8 percent; and unidentifiable material, 2.7 percent. The fishery literature shows that the staples of this trout diet are similar to those of the fish species that formerly inhabited the lake.

It appears, therefore, that Surprise Lake—and probably similar rehabilitated lakes—have a food supply and a carrying capacity in rainbow trout that are not being utilized fully at present Minnesota rates (about 150 3- to 6-inch fish per acre per year) and that heavier stocking might be expected to produce a larger standing crop and greater yield to the angler.

332. Corson, B. W. 1955. FOUR YEARS' PROGRESS IN THE USE OF ARTIFICIALLY CONTROLLED LIGHT TO INDUCE EARLY SPAWNING OF BROOK TROUT. The Progressive Fish-Culturist, Vol. 17, No. 3, July, pp. 99-102.

The magnitude of the early spawning program in New Hampshire has been governed by the carrying capacity of nine hatcheries and rearing stations in relation to the five other species of salmonoid fish they propagate. The peak spawning activities for brook trout (Salvelinus fontinalis) in this region occur during November; however, since 1951 New Hampshire has continued a program of collecting eggs from brook trout during August, as a result of the early maturation of gonads induced by modification of light.

The site of this project was established at the New Hampton Hatchery of the New Hampshire Fish and Game Department late in the fall of 1951. At that time the engineer designed a wooden brood house to enclose four pools with dimensions of 5 by 50 feet, these pools being supplied with a constant flow of spring water at the rate of 126 gallons per minute and temperatures not exceeding 43° F. The front section, which has a total of 884 square feet, was designed so that 126 square feet of hinged panels could be opened, allowing daylight to be used during those periods when the project was inactive. The rear wall of the building has 676 square feet, of which 154 were allowed for hinged-panel openings in staggered opposition to those on the front wall in order to permit a more even distribution of natural light.

A time switch was installed to control 12 overhead 150-watt mediumbase reflector flood lamps that supplied the artificial light to induce early spawning activities. The light intensity, expressed in lumens per square foot at water level, was recorded at 40 with all panels closed. The vertical distance from the surface of the water to the light bulb is 8 feet.

The following light schedule is annually initiated on January 15: 1 hour a day in excess of the normal daylight period for the season at 44° latitude for the first week, 2 hours for the second week, etc., until use of 9 hours of artificial light in excess of the normal light period has been reached. The light is then maintained on this schedule for a period of 4 weeks, after which the light is decreased 1 hour weekly until the normal daylight period for that date is reached. Thereafter, all the panels on the brood house are closed and, by switching to the use of artificial lights, the "day" is shortened 1 hour weekly until there are 4 hours less of artificial light than there are hours in the normal daylight period for that date. The light-control switch remains fixed to maintain this condition until the fish ripen.

On January 2, 1952, 1,615 females and 835 males were transported to the New Hampton Hatchery and placed in the brood house. This resulted in a carrying capacity of approximately 1.5 pounds per cubic foot of water. On January 15, 1952, controlled light operations were started as already described.

Commencing on August 28, 1952, 2,655,000 eggs were collected from 1,300 trout of the 2.5-year-old class, averaging 2,000 eggs per female. The eggs were small (450 to the ounce); but although losses encountered during the period of incubation were higher than normal, those eggs that reached the eyed stage (some 1,500,000) developed into excellent fish.

The following year, commencing on January 15, 1953, the procedures were repeated, using the same brood stock. Commencing on August 13, 1953, 410,000 eggs were collected from 135 females, an average yield of approximately 3,037 eggs per fish. The eggs were small (531 per ounce) and exhibited much buoyancy prior to reaching the eyed stage; therefore, egg collections were curtailed at that point. The egg losses were heavy, and many of the fish from this stock were deformed. After the removal of these culls, the remainder of the fish developed normally and in development were very similar to the previous lot. The use of 3.5-year-

old stock for the second series of experiments clearly demonstrated that, when carrying 3.5-year-old stock, there were many problems that were not evident when carrying 2-year-olds. Therefore, it was decided to use 2-year-old stock hereafter.

For the third year of the experimentation in light modification, 800 females and 400 jack yearlings were transferred to New Hampton. The experiment started on January 15, 1954; and, as these were yearlings which had only partly thrown their eggs, it again became necessary to carry the fish through a refractory period in the sexual cycle. Egg-collecting operations were started on August 9, 1954, and 697,734 eggs (with an average count of 420 per ounce) were collected from 268 females. The average yield (approximately 2,600 per fish) was higher than previous results. It was noted that, although the eggs were small, this lot suffered only normal losses and the resulting fingerlings were excellent.

As a result of findings, personnel of the New Hampshire Fish and Game Department are firmly convinced that the use of 2.5-year-old brook trout for brood stock is more satisfactory than maintaining fish of the 3.5-year-old class for the same purpose. The results in general have been favorable and the work is considered a successful phase of the State's over-all production program.

333. Whalls, Marvin J., Karl E. Proshek and David S. Shetter. 1955. A NEW TWO-WAY FISH TRAP FOR STREAMS. The Progressive Fish-Culturist, Vol. 17, No. 3, July, pp. 103-109.

A new type of two-way fish trap has been developed at the Hunt Creek Fisheries Experiment Station in Michigan. Its primary function is to confine migrating brook trout temporarily in order to determine the annual movements of these fish in the stream. The article is well illustrated with photographs and diagrams and directions for its construction are given.

334. Adelman, Harvey M., Joseph L. Bingham and Jack L. Maatch. 1955. THE EFFECT OF STARVATION UPON BROOK TROUT OF THREE SIZES. The Progressive Fish Culturist, Vol. 17, No. 3, July, pp. 110-112.

This study was designed to test the hypothesis that starvation is a significant determinant of the fishes' inability to sustain the winter months. In general, the procedure was to deprive three groups of brook trout (Salvelinus fontinalis)—3.5 inches, 5.5 inches, and 7.5 inches in length—of food for 7 months. The complete study was conducted at the Oden Hatchery, Emmet County, Michigan, during the period from September 15, 1953, through April 15, 1954. The fish were placed in sections of a standard hatchery fingerling trough. The sections were 13 inches long, 14.5 inches wide, and 10 inches deep. Water level was kept at 7 inches, and a constantly changing water supply flowed from a ground source at the rate of 6 gallons per minute. The water temperature was 45° F., plus or minus 0.5°.

Each of the length groups was divided randomly into two groups of 20 fish each. Half of each length group was weighed and measured weekly for a 1-month period and biweekly thereafter, while the remaining half served as a control for the handling procedures. In addition, the 7.5-inch group was divided into four randomly selected groups. Two groups of 20 (X1) fish each were confined in a space comparable to that of the 3.5- and 5.5-inch groups, and two groups (X2) of 20 fish each were confined in an area three times as large.

The weight of all four groups gradually declined in the initial phases of the study and remained relatively constant over the last 4 months of starvation. The magnitude of decrease from the initiation to the termination in all four groups was not statistically significant. The two groups of larger fish showed more loss of weight than did either of the groups of smaller fish. As the groups of larger fish showed fewer continuous mortalities, the relative weight constancy of the smaller fish may have been due in part to the death of the fish which would have reduced the mean weight of the groups.

As handling and amount of confinement space had no systematic influence upon survival rate, the results portrayed are for the three major experimental groups. Hunger produced the most detrimental effect on the 3.5-inch fish, which survived at the rate of 30 percent at the end of 7 months. The 5.5-inch fish and the 7.5-inch fish survived at rates of 90 percent and 75 percent, respectively. Blood counts taken in March revealed that even after 5 months of complete food deprivation, none of the fish had a pathologically low count and—although the smaller fish had lower counts—all were well within the normal range.

Upon termination of the study in May, the groups were divided at random into a demand-feed group and a slow-feed group. All the fish in the first group died, whereas none in the slow-feed group revealed these debilitating effects. Thus, it would seem that after a prolonged period of starvation, fish must be fed slowly to insure recovery. From the results of this study it is evident that, for larger fish, at least, starvation per se could not be an important variable in low winter survival rates.

335. Parkhurst, Zell E. and Harlan E. Johnson. 1955. TOXICITY OF MALATHION 500 TO FALL CHINOOK SALMON FINGERLINGS. The Progressive Fish-Culturist, Vol. 17, No. 3, July, pp. 113-116.

Studies to determine toxicity of malathion 500 to fall chinook salmon fingerlings were made recently near Cook, Washington, at the Little White Salmon Fish-Cultural Station of the U. S. Fish and Wildlife Service. Personnel of the U. S. Public Health Service assisted in the planning and execution of the experiments.

Malathion 500 is an emulsifiable concentrate of the insecticidal thionophosphate known as

malathion (o, o - dimethyl dithiophosphate of diethyl mercaptosuccinate) with aromatic petroleum derivative solvent (31 percent) and other inert ingredients (12.5 percent). Malathion is said to have insecticidal properties similar to those of parathion and tetraethyl pyrophosphate, being a cholinesterase inhibitor, but to be much less toxic than these to man and other mammals.

The test animals were fall chinook salmon fingerlings about 1.5 inches in length. Nine slightly inclined wooden hatchery troughs, painted inside and outside with aluminum paint, were utilized as test aquaria.

The volume of water in each trough was approximately 590 liters. Malathion 500 is said to contain 5 pounds of malathion (active ingredient) per gallon, which is equivalent to 1 gram of the active ingredient in 1.67 milliliters of the commercial product, or 1 milligram in 0.00167 milliliter. Accordingly, 0.985 milliliter of Malathion 500 (0.00167 milliliter x 590) added to the water in the trough should give a concentration equivalent to 1 part per million of the active ingredient. All concentrations reported herein were computed on this basis.

Different amounts of Malathion 500 (emulsified by being mixed in a flask with 99 times its volume of water and then shaken vigorously) were added to the water in seven of the troughs; the remaining two troughs served as controls. In the first experiment, begun on March 30, 1954, the measured quantities of concentrated emulsion were added directly to the water in the troughs; whereas in the second experiment, started on April 12, 1954, these quantities were made up to 1 liter with water —so as to promote uniform dispersion of the toxicant—before being poured into the troughs. After the experimental dilutions of the toxicant in the troughs had been thoroughly stirred, 20 salmon fingerlings were introduced into each trough. Periodic observations and records of the mortality were made for 6 days thereafter.

The bioassay results that are reported show that a concentration of emulsified Malathion 500 equivalent to 0.1 part per million of malathion (active ingredient) can be decidedly harmful to chinook salmon fingerlings. One toxicity evaluation showed the 24-hour, 48-hour, and 96-hour median tolerance limits to be about 0.17, 0.15, and 0.12 part per million of malathion, respectively, at temperatures of 47° to 49° F. The results of an earlier, preliminary series of tests indicated somewhat greater toxicity and a 96-hour median tolerance limit (concentration at which just 50 percent survive for the specified period) a little below 0.1 part per million of malathion (at 44° to 48° F.); but 0.032 p.p.m., the next lower concentration tested, killed no fish in six days. Results of some later tests, wherein the insecticide was added to the water, 48, 96, and 144 hours before the introduction of the test fish, agreed with the results of the first-mentioned toxicity evaluation (second experiment) and revealed no important change in the toxicity of the emulsions with aging.

336. Haskell, David C. 1955. WEIGHT OF FISH PER CUBIC FOOT OF WATER IN HATCHERY TROUGHS AND PONDS. The Progressive Fish-Culturist, Vol. 17, No. 3, July, pp. 117-118.

Among hatchery personnel there exists little agreement on the safe carrying capacity of troughs or ponds. The method to be described here has been used at Rome, New York, for several years and, although admittedly not based on scientific data, is nonetheless considered valuable in the management of this hatchery.

The number of factors affecting carrying capacity makes preparation of general rules very difficult. These factors probably include species; fish size; water flow; water quality, i.e., dissolved oxygen, carbon dioxide, hardness; sanitation practices; type of food; and method and timing of feeding. If, however, two assumptions may be made, a rather simple rule may be derived for estimating the carrying capacity. These assumptions are—(1) carrying capacity is limited by (a) oxygen consumption and (b) accumulation of metabolic products; and (2) amount of oxygen consumed and the quantity of metabolic products are proportional to the amount of food fed. When these assumptions are applied, the maximum safe density of brown trout in a trough will be that weight of fish which requires 0.13 pound of feed per day per cubic foot of water. As for each temperature and size there is a recommended feeding level, one may use the following equation (wherein W is weight and BW is body weight): $W \text{ of feed} = \frac{\%BW \times W \text{ of fish}}{100}$ or $W \text{ of fish} = \frac{W \text{ of feed} \times 100}{\%BW}$. Since a maximum feeding level of 0.13 pound per day per cubic foot has been defined, permissible $W \text{ of fish} = \frac{0.13 \times 100}{\%BW} = \frac{13.}{\%BW}$

Using the last equation, one may look up the recommended feeding level for any size and temperature and easily calculate the permissible weight of fish.

At Rome, the following equation is used for the rearing ponds: Permissible $W \text{ of fish} = \frac{0.02 \times 100}{\%BW} = \frac{2}{\%BW}$. Thus, ponds are considered to have a carrying capacity of about one-sixth that of troughs on a cubic foot basis.

If the weight of feed per cubic foot is constant and one assumes a uniform conversion, then—for a trough or pond held at the maximum density—the production per cubic foot will be constant for all sizes and temperatures. Assuming a conversion of 3.0, production per cubic foot in troughs may be derived from the equation—

$\text{Gain} = \frac{W \text{ of feed}}{\text{Conversion}} = \frac{0.13}{3.0} = 0.043$ lb./day, 1.29 lbs./30-day month, 15.7 lbs./year.

For ponds, an equivalent production per cubic foot would be—0.0067 lb./day, .20 lb./30-day month, 2.44 lbs./year.

Under the limits imposed and the assumed conversion, this production cannot be attained unless the pond or trough is kept constantly at the maximum

permissible poundage—which is practically impossible. The figures given constitute an upper limit or production under these circumstances.

337. Kennedy, Harry D. 1955. COLONIZATION OF A PREVIOUSLY BARREN STREAM SECTION BY AQUATIC INVERTEBRATES AND TROUT. The Progressive Fish-Culturist, Vol. 17, No. 3, July, pp. 119-122.

In the spring of 1950, during trout survival studies at the Convict Creek Experiment Station of the U. S. Fish and Wildlife Service in eastern California, there was an excellent opportunity to measure the extent to which aquatic invertebrates and stream-resident brown trout colonized a previously barren stream section.

Convict Creek has been divided into four experimental stream sections which are used in the study of survival of hatchery-reared rainbow trout and stream-resident brown trout. Water control and screen structures designed to accommodate flows of as much as 100 second feet separate the various sections. Flows that are in excess of this amount are diverted around the experimental area by means of a flood-bypass channel which originates at a flood-control structure near the up-stream boundary of the area. Abnormal high water necessitated diversion into the bypass on May 1, 1950, and this flow prevailed until July 26, 1950—87 days. The bypass had been dry for several years prior to this use, and it was, therefore, easy to determine the extent of colonization of aquatic forms in this newly watered habitat. All brown trout which had entered the bypass area were recovered alive on the day the channel was dewatered and were compared with recoveries from a section of the stream (section 3) which contained an established population of brown trout.

There are no pools in the bypass channel and it is devoid of shelter, except for that afforded by boulders, particularly in the upper one-third of its course. Stream bank cover is limited to sagebrush and rabbit brush growing on the crests of excavated material, but not near the waterline. Bottom material consists of boulders, rubble, and large gravel. Because of the steady gradient of the channel, sandy areas are limited to small pockets on the downstream sides of boulders.

There was similarity in species of aquatic invertebrates taken from the bypass and from Convict Creek, but on the average greater numbers were taken from the bypass. Although it seemed likely that the invasion and establishment of most invertebrates in the bypass resulted from their being carried there by the current, drift nets fished on Convict Creek failed to reveal even moderate numbers of stream-borne aquatic organisms.

All trout occupying 3,000 feet of the bypass channel were recovered after the closure of the diversion gates. The extent of movement of trout into the bypass is indicated by the number recovered (224). On the basis of square feet of bottom area, it is seen that the normal stream population in experimental stream section 3 was 4.6 times as dense as the new colony found in the bypass. In the bypass there was 1 trout per 134 square feet of bottom area, and in experimental stream section 3 there was 1 trout per 29 square feet of bottom area.

338. Schumacher, Robert E. 1955. GROWTH OF BROWN TROUT FINGERLINGS ON A DIET FORTIFIED WITH AUREOMYCIN AND THIAMINE HYDROCHLORIDE. The Progressive Fish-Culturist, Vol. 17, No. 3, July, pp. 123-125.

At Minnesota trout hatcheries in 1952, brown trout (Salmo trutta fario) were fed a diet consisting of 45 percent ground beef spleen and 55 percent dry-cereal mixture. Whole frozen spleen, obtained from a local meat-packing plant, was thawed and ground at the hatchery. To this ground spleen was added a dry-cereal mixture consisting of 22 percent each of soybean meal, cottonseed meal, red-dog wheat flour, and spray-dried skim milk, plus 2 percent salt and 10 percent dried brewer's yeast. The completed food was prepared in the form of semimoist pellets about one-fourth inch in diameter.

As part of a continuing program for the development of better trout diets, a feeding experiment using brown trout fingerlings was conducted to evaluate the effect that adding aureomycin and thiamine hydrochloride to the foregoing diet would have on growth. This feeding experiment was conducted at the St. Paul Fish Hatchery during the period August 18, 1952, to December 18, 1952.

Twelve hatchery troughs were used. These troughs were 14 feet long and 14 inches wide and had 6 inches of water in them. They received water from a natural spring augmented by water from an artesian well. Water temperatures remained within 1° of 50° F. during the experiment.

Three pounds of brown trout averaging 742 to the pound were placed in each of the 12 troughs. Trout in 4 of the troughs were fed the diet already described and hereafter called the control diet. Trout in another set of 4 troughs were fed the control diet which had been fortified with at least 6.26 grams of aureomycin per 100 pounds of food. Trout in the third set of 4 troughs were fed the control diet which had been fortified with at least 6.26 grams of aureomycin and 10.0 grams of thiamine hydrochloride per 100 pounds of food.

Aureomycin used in this work was in the form of Aurofac 2A, which is guaranteed to contain at least 3.6 grams of pure aureomycin per pound of Aurofac. The thiamine (vitamin B_1) used was chemically pure thiamine hydrochloride.

At the beginning of the experiment, the trout were fed at the rate of 8 percent of their body weight per day. The feeding rate was reduced as the fingerlings increased in size, until at the end of the experiment they received 4.5 percent of their body weight per day. Minimum feeding level for aureomycin was 4.98 milligrams per pound of trout per day at the beginning of the experiment and 2.817 milligrams at its conclusion. Similarly, minimum feeding level for thiamine hydrochloride was 8.0 milligrams per pound of trout per day at the beginning of the experiment and 4.5 grams at its conclusion.

The percentages of body weight gained per period and the food conversion factors were similar for the trout on the control diet and the trout on diets fortified with aureomycin and aureomycin plus thiamine. Differences were small; to evaluate them, a Chi-square common distribution test was applied to the percentages of body weight gained per period. This analysis gave a value of 1.278, which, at 14 degrees of freedom, indicates a Chi-square probability of 0.999. It is concluded, therefore, that the growth of the brown trout fingerlings was not increased significantly by adding given levels of aureomycin or aureomycin plus thiamine to the control diet described.

339. Johnson, Leon D. 1955. CONTROL OF ULOTHRIX ZONATA IN CIRCULAR PONDS. The Progressive Fish-Culturist, Vol. 17, No. 3, July, pp. 126-128.

The St. Croix Falls Hatchery, Wisconsin, maintains 12 circular ponds among its facilities for rearing eastern brook trout. Circular ponds are used because of their inherent design for self-cleaning. Ponds remain self-cleaning until their surfaces become covered with dense growths of filamentous algae, Ulothrix zonata (Weber and Mohr) Kuetzing 1833. When allowed to grow, the matted filaments of Ulothrix attain lengths of 2 to 3 inches in as many weeks. The untidy appearance of such ponds and self-cleaning action are improved only by removing the Ulothrix. The physical labor involved, however, is excessive, as 36 man-hours per week are required to scrub the 12 ponds in the summer season.

Many anti-fouling copper-compounded paints and rubber-base swimming pool paints have been applied to the concrete ponds in order to provide a surface on which Ulothrix cannot grow. The paints already tested exhibit only short-term inhibiting qualities and are expensive. Algal growth is retarded in ponds that are thoroughly dried and refilled, but this is inconvenient when ponds are needed to hold fish. There is also danger that dry ponds may crack from the heat of the sun.

Delrad 70 (Rosin amine D acetate 70-percent solution in water) was selected as a possible control agent for Ulothrix zonata. Trials using Delrad in hatchery waters of methyl orange alkalinity 127 parts per million, expressed as $CaCO_3$, indicated that 0.25 to 0.50 p.p.m. active ingredient Delrad killed Ulothrix in 5 to 6 hours at temperatures of 48° to 50° F. with no apparent deleterious effects on brook trout fingerlings.

Best control was attained by placing 15 grams of Delrad 70, paste form of the algaecide, in a modified piece of pipe (2 inches in diameter) with 1/4-inch mesh screen soldered to the bottom. Size of mesh had little effect on the dispersal of the algaecide, but the 1/4-inch mesh remained free of debris longer than smaller mesh. This applicator pipe was suspended by a hook into the water at the pond edge, the open end of the pipe being above the surface. The quantity of Delrad 70 required was based on the computed volume of water for each of the ponds (each 18 feet in diameter) plus the additional inflow of 30 gallons of water per minute over a 5-hour period. Under the described conditions, circulating pond waters evenly distributed the algaecide at the desired rate of approximately 0.5 p.p.m. concentration of active ingredient for 4 to 6 hours.

With further trials, it was found that Delrad 70 placed in the applicator pipe in quantities ranging from 5 to 30 grams killed Ulothrix without harming the trout. With allowable variations in the dosage of algaecide, it became a simple matter to dispense a lightly rounded tablespoonful or heaping teaspoonful (each approximately 15 grams) of the algaecide per pound on a weekly or monthly basis or as needed. This labor involved only 10 minutes per application.

The Ulothrix declined with successive chemical treatments, but diatoms increased to such an extent that concrete surfaces became coated with a thin film that resembled brown paint. The disadvantage of diatom color was outweighed by the following advantages: (1) ponds continued to be self-cleaning; (2) Ulothrix was suppressed, even though algaecide treatments were discontinued; (3) dark diatom color seemed to be preferred by the trout and (4) diatoms were scrubbed from concrete surfaces more easily than the Ulothrix filaments when it became necessary to work in ponds.

Whenever the dispenser is used for the first time at a hatchery or under different water conditions, it is advisable to use the algaecide on only a few trout for the first times. It may be necessary to slow the diffusion process by using a pipe of smaller diameter or to hasten the release of algaecide by submerging the top and bottom of the pipe in the water.

340. Elser, Harold J. 1955. AN EPIZOOTIC OF ICHTHYOPHTHIRIASIS AMONG FISHES IN A LARGE RESERVOIR. The Progressive Fish-Culturist, Vol. 17, No. 3, July, pp. 132-133.

Epizootic infestations with the protozoan parasite, Ichthyophthirius multifiliis, among fishes in a large reservoir in the United States have not been reported previously. This paper reports a lethal outbreak of ichthyophthiriasis in Deep Creek Lake, a 3,900-acre impoundment in Garrett County, Maryland, in the spring of 1954. The disease affected chiefly the yellow perch (Perca falvescens) population.

An estimate of the kill of fish by the end of May was 170,000. This is 7.5 times the total number of perch taken by the lake's anglers in 1951, 1952, and 1953. Of the dead fish seen at the 45 sampling stations, only 4 were not yellow perch, but these fish had been dead so long as to preclude identifying the cause of death. All newly dead perch showed the characteristic blotches of ichthyophthiriasis. By mid-June, the eipzootic had subsided considerably, although dying perch were still scattered about the lake. By the end of June the disease had run its course.

Trap-netting in mid-June disclosed that the brown bullhead population was very much afflicted with columnaris, and the rock bass with an uniden-

tified copepod. Examination (with hand lens) of non-perch species in the trap nets revealed what appeared to be occasional Ichthyophthirius on largemouth bass, rock bass, and golden shiners, but the disease in these species apparently did not reach as great proportions as with the yellow perch.

341. Bowers, Charles C. 1955. SELECTIVE POISONING OF GIZZARD SHAD WITH ROTENONE. The Progressive Fish-Culturist, Vol. 17, No. 3, July, pp. 134-135.

Rotenone treatment to kill shad without harming other fishes was first attempted in Kentucky on Kentucky Lake in the summer of 1950. In this experiment the idea was to use rotenone at standard concentrations directly on the surfacing schools of shad. It was reasoned that 1 pound of rotenone per surface acre in pelagic areas would form a lethal concentration in the top few feet of water, where the shad were observed, and would dilute to a nonlethal concentration as it sank into deeper water where the other species normally would be found. This work was done in the middle of the day during the summer, when shad were at the surface in large schools.

Although this experiment was successful in that practically no other fishes were killed, the time consumed and the effort expended in spraying individual schools of shad were not justified by the relatively small percentage of the total shad population killed.

In the summer of 1954, a serious shad problem was found to exist in Carpenter Lake, a 70-acre state-owned impoundment located 9 miles northeast of Owensboro, Kentucky. It was decided to attempt to poison shad selectively with a low concentration of rotenone. Final plans were made to treat the lake in October 1954. At the time of treatment, the water had a temperature of 65° F., a pH of 7.4, and a total alkalinity of 60 p.p.m. The depth averaged 5 feet; the maximum was 11 feet.

A mixture of 5 percent powdered rotenone was sprayed over the lake surface with a gasoline-powered centrifugal pump operated from an outboard motorboat. An attempt was made to control the spray so as to get not more than 0.10 p.p.m. in the shallow areas and at least 0.10 part p.p.m. in the deeper areas. Shad began showing signs of distress within 15 minutes after each area was sprayed. No additional rotenone was needed. The shad died within an hour after treatment, except for a few individuals which were still surfacing at nightfall. All activity was over by the next morning. Shad did not float to the surface in great numbers until the second day after treatment. In 7 days, 14,050 pounds of shad were picked up and buried, and an estimated 6,000 pounds decomposed and sank before being picked up. One area was resprayed 3 days later to determine whether any shad had survived the original treatment.

Within 3 days a definite increase in fishing success was noted, bass activity around the bank of the lake being quite noticeable. Two hundred and eighty-five pounds of shad per acre were removed from this lake with the loss of less than one pound of game and pan fish per acre.

342. Moyle, John B. 1955. SPORT-FISHING TRENDS IN MINNESOTA. The Progressive Fish-Culturist, Vol. 17, No. 3, July, pp. 136-137.

Reliable records of sport fishing prior to extensive stocking of inland lakes and recent heavy fishing pressure are scarce. Recently such a record—a log of the Monmouth-Miltona Fishing Club of Alexandria, Minnesota, for the years 1894-97—has become available. Catch data in this log throw some interesting sidelights on the sport-fishing trends in Minnesota.

The 15 members of this club fished in 7 typical hard-water morainic lakes of west-central Minnesota. The bulk of the fishing was on Lake Miltona (5,322 acres), Lake Ida (4,643 acres), and Spring Lake (145 acres)—all in Douglas County. For the summers of 1894-97, there are recorded 1,424 angler-trips, on which 17,198 fish were caught. This provided an average catch of 12.1 fish per angler-trip.

The table has been prepared to show the percentage composition of the 1894-97 catch from the 7 lakes. For general comparison, the percentage composition of the summer catch in 1952 for 6 similar—but not the same—lakes in western Minnesota is also included. Average catch rate from these lakes in 1952 was 2.4 fish per fisherman-trip. Percentage composition of summer angling catch:

Species	1894-97 (seven lakes)	1952 (six lakes)
Black Basses	47.80	2.3
Rock Bass	28.70	3.2
Walleyes	7.40	11.2
Northern Pike	3.20	14.6
Crappies	6.90	12.1
Sunfishes	6.00	47.6
Bullheads	.05	4.6
Perch	0	4.6

The divergence in catch per trip—from 12.1 fish in 1894-97 to 2.4 in 1952—may not be so great as it appears, since expert fishermen are being compared with a cross section of the present angling public. But it seems safe to say that fishing was really better 60 years ago. However, the yield of sport fish per acre is almost certainly higher now because of more complete utilization of fish populations. It is of interest to note also that even in 1894-97 there were times when fishing trips yielded no fish.

343. Hansen, Donald F. 1955. A METHOD OF NUMBERING DEPTH GRADUATIONS ON HAND LINES. The Progressive Fish-Culturist, Vol. 17, No. 3, July, pp. 138-139.

This method of numbering depth graduations was originally used on the underwater cable of an electric thermometer. The present system has been used on a braided cotton line and on a plastic line. Essentially, a number is embossed on a metal strip, and this strip is bent to the shape of the line and attached to it by means of water-resistant tape.

The markers for the lines mentioned were numbered on an embossing press, or labeling machine, which stamped a figure 1/4 inch high on an aluminum strip, 1/2-inch by 1/64-inch. This machine was equipped with "high relief" type. To prevent jagged breaks in the metal when the strips were bent to fit the lines, the downward movement of the embossing-press handle was made 1 to 1 1/2 inches short of a normal stroke.

Bending the embossed strip to fit halfway around the line requires preparation of a grooved wooden block. The block should be of soft wood, such as ponderosa pine. A hole 1/4 inch in diameter is drilled through the block, and the end of the block is sawed off so that the saw passes 1/32 inch above the centerline of the hole. With the block clamped in a vise (to prevent the wood from splitting), a few light blows with a hammer on a round rod or drill shank will force the flat metal strip to assume the shape of the groove. The hole drilled for the groove and the rod used in bending the markers should be of the same diameter as the line that is to be graduated.

Two turns of plastic electrical tape—a tape selected after a number of careful tests, as well as consultation with electricians, to determine the brand that would provide the best adhesion under these circumstances—proved satisfactory for holding the markers to the lines. Recent examination of lines in use 2 to 3 years, however, indicates that this tape may be somewhat better suited for use on rubber-covered cable and cotton sash cord than on plastic clothesline. The tape used on the plastic line has not unwrapped, and the markers have not shifted from their original positions, but the tape appears somewhat stretched and the markers are slightly loose.

344. Walker, Charles R. 1955. A CORE SAMPLER FOR OBTAINING SAMPLES OF BOTTOM MUDS. The Progressive Fish-Culturist, Vol. 17, No. 3, July, pp. 140.

For sampling bottom mud in shallow waters, a core sampler was made from an automobile tire pump. The foot of the pump was removed from barrel and plunger. Several holes were bored in the upper part of the barrel to allow free flow of water as a sample is taken. The lower end of the barrel was honed to a sharp cutting edge. A rod cut to the length adequate for the working depth desired was fastened to the barrel with two universal clamps and graduated in inches to measure the depth of sampling. The plunger also was graduated so that any desired depth of sample could be separated for analysis.

Samples are obtained at the desired water depth by ramming the sampler down to the clay subbottom, thus sealing the sample in the barrel. A twisting motion helps to remove the sampler from the bottom. After the sample is obtained, bottom ooze is removed by pushing the plunger to the more solid material, turning the sampler on its side, and drawing the plunger back slowly. The ooze will run from the holes in the barrel and can be caught in a jar. The rest of the sample is removed by pushing in the plunger. The graduated plunger rod serves to aliquot portions of the sample according to the desired depth. Ooze, usually lost in other sampling methods, is easily retained in this device. Use of this method is limited to bottom materials of fine consistency. The sampler works best on bottom muds where ooze is shallow.

345. Stoddard, James V. 1955. FARM PONDS FOR FOOD AND FUN. Wyoming Wildlife, Vol. 19, No. 8, August, pp. 22-26.

This article on how to construct and stock a farm pond points out that a half-acre pond will yield approximately 100 pounds of fish a year, providing it receives a little necessary care. Aquatic plants do not have to be raised, because recent experience in farm fish pond management has proved them to be undesirable in many instances. Of course a certain amount of controlled aquatic plant life is sometimes desirable. One or two-acre ponds are easily fertilized and stocked. Mosquitoes and unwanted weeds can be controlled with but little effort, although the author points out that larger ponds will present difficulties.

It is recommended that the dam be of sufficient height to provide for a depth of at least 10 feet, over 1/5 of the pond area, with fast-sloping banks which drop quickly from water level to three feet in depth. Ponds with only a small overflow are found to be the easiest to operate as there is then little loss of fertilizer.

The suggested application of fertilizer per surface acre of farm ponds is: for neutral or acid water, 100 pounds of 6-8-4 mixture (6 percent nitrogen, 8 percent phosphoric acid as a source of phosphorus, and 4 percent potash for potassium) with 10 pounds nitrate of soda added separately. For alkaline waters (containing more than 8 p.p.m. of hydrogen) 100 pounds of this same 6-8-4 mixture with 10 pounds of sulphate of ammonia added in place of the soda.

When stocking largemouth bass, which is a carnivorous species, a suggested basis for stocking one acre of a new fertilized pond is 100 small fish, 200 bluegill bream, and for an acre of non-fertilized pond 30 largemouth bass and 60 bluegills would be introduced. It has been stated that a pond which can support 150 total pounds of fish would have 50 pounds of bass and 100 pounds of bluegills. If the pond is spring-fed, trout will probably be the desired stock, providing, of course, that the water flow is sufficient to maintain a pond temperature which does not exceed 70° F.

346. Job, S. V. 1955. THE OXYGEN CONSUMPTION OF SALVELINUS FONTINALIS. Univ. of Toronto Biological Series No. 61, Publ. of the Ontario Fish. Res. Lab., No. 73. 39 pp.

The investigation presented in this paper was undertaken in order to study in the speckled trout the relation of size to the effects of the environmental factors of temperature and partial pressure of oxygen upon oxygen consumption. Although there have been many measurements of metabolism in relation to size, there is no complete description for

any one species of fish where oxygen consumption is related to size, temperature, and the environmental oxygen pressure. Beyond any virtue which may be attached to thoroughness, such a complete description of the rate of oxygen intake in relation to size has value in the following ways. Appropriate measures of the rate of oxygen uptake indicate the capacity of the organism to perform external work in relation to its size. Size also must be considered in relation to effects of oxygen concentration and temperature upon the uptake. Finally estimates of oxygen uptake in relation to size considered in conjunction with growth rate and the calorific equivalent of the metabolic rate permit estimates of the total energy requirement of the individual.

The oxygen consumption of the speckled trout, both wild and hatchery stocks, ranging in size from 4 gm. to 1000 gm. was measured after appropriate acclimation at 5°, 10°, 15°, and 20° C. Two measurements, viz., of a standard rate which was the minimum observed under conditions of rest and an active rate observed under conditions of steady exercise, were made. These two levels are taken to approximate respectively minimum and maximum rates of oxygen intake. Findings are discussed in detail.

347. Clay, William M. and Ernest A. Lachner. 1955. OCCURRENCE OF THE LAMPREY ICHTHYOMYZON GREELEYI HUBBS AND TRAUTMAN IN KENTUCKY. Trans. of the Ky. Acad. of Sci., Vol. 16, No. 2, May, pp. 53-55.

The four non-parasitic species of the lamprey genus Ichthyomyzon are distributed in a pattern which more or less surrounds Kentucky. None of these forms has previously been reported from Kentucky.

Four specimens of Ichthyomyzon greeleyi Hubbs and Trautman, U. S. National Museum 163022, were collected in Russel Creek, a tributary of Green River, 1 mile southeast of Columbia, on Kentucky 80, in Adair County, Kentucky, on April 25, 1952. The Kentucky specimens agree quite closely with I. greeleyi Hubbs and Trautman and differ in one or more significant characters from each of the others. They differ from Ichthyomyzon hubbsi Raney in the presence of a corneous layer and denticulations on the transverse lingual lamina and in having a higher anterior dorsal fin, and from I. gagei Hubbs and Trautman in the cornified, denticulate, and perhaps more bilobed lingual lamina. They differ from I. fossor Reighard and Cummins in several respects: the transverse lingual lamina is apparently less strongly bilobed and somewhat more cornified and more denticulate than in most specimens of fossor, the number of trunk myomeres is greater, the number of supraoral cusps is three rather than two, and bicuspid circumorals are present (seven or eight in number) rather than absent. The last difference probably is the most significant.

The recorded range of I. greeleyi, the Allegheny Brook Lamprey, is within the upper Ohio River system of western Pennsylvania and eastern Ohio. The present record extends the known range of I. greeleyi approximately 400 miles, from the upper Ohio to the Green River drainage in the lower Ohio River system.

348. Hancock, Hunter McRae. 1955. AGE AND GROWTH OF SOME OF THE PRINCIPAL FISHES IN CANTON RESERVOIR, OKLAHOMA, 1951, WITH PARTICULAR EMPHASIS ON THE WHITE CRAPPIE. Part II of a report to the Okla. Fish and Game Council, Okla. A & M College, Stillwater, 110 pp., mimeo.

Age and growth patterns, length-weight relationships, and coefficients of condition for 14 species of fishes from Canton Reservoir, Oklahoma, in 1951 are presented by a series of tables and graphs. The role of each species in the fish population complex is briefly discussed and management measures are recommended.

349. Phillips, Arthur M., Jr., Floyd E. Lovelace, Henry A. Podoliak, Donald R. Brockway and George C. Balzer, Jr. 1954. THE NUTRITION OF TROUT (Cortland Hatchery Report No. 23, for the year 1954). N. Y. Conservation Dept. Fish. Res. Bulletin No. 18, 52 pp.

Previous experiments in this laboratory (Phillips et al, 1952, 1953) show that small, non-feeding brook trout absorb radioactive calcium and radioactive phosphorus directly from the water without these two minerals being a part of the natural food chain. Since hatchery waters and natural waters differ widely in the amount of calcium and other minerals present, further study of the absorption of calcium by brook trout is necessary. A knowledge of the amount of calcium absorbed by trout, of how the composition of the water influences this absorption, and of the distribution of the metabolized absorbed calcium within the trout's body is basically important and can be applied to hatchery and stream management.

Calcium is absorbed by small non-feeding brook trout from the water, the amounts absorbed over a 96-hour period depending on the chemical composition of the water. Distribution of the absorbed calcium within the body is a function of the calcium content of the body parts and is independent of the water. The rate of distribution of absorbed calcium is a function of metabolic activity, which is shown to be dependent upon the physical composition of the water. The rate of distribution of calcium increases in concentrations less than 50 p.p.m. in distilled water. Increased concentrations of minerals other than calcium in the water increases the ability of the fish to absorb and metabolize calcium.

Non-feeding brook trout absorb cobalt^{60} from the water through the gills. A larger amount of cobalt^{60} is deposited in the digestive tract (pyloric caeca attached) than in the liver. This may be a function of elimination or of the formation of a complex compound described as present in the pyloric caeca of fish.

Fish size, sodium amytal, water temperature, and starvation are all effective in reducing the metabolic rate of trout. The interaction of all these

variables is the most efficient means of metabolism control. Generalizations are offered for the effective control of metabolism under a variety of conditions.

Application of the proper interactions of the metabolism studies results in carrying fantastically large loads of fish over a 12-hour period. Up to 62.4 pounds of fish per cubic feet of water are carried successfully under the proper conditions. Variables considered are starvation, water temperature, sodium amytal, fish size, and weight of fish per volume of water.

Pyridoxine and riboflavin are necessary factors for the normal growth and survival of brown trout.

No need is shown for either vitamin A or vitamin D in the diet of brook trout.

The phospholipid cephalin appears to be a growth stimulator for brook trout. The interaction that is found between the fatty acids of cod liver oil, cod liver oil concentrate, and cephalin, indicates cephalin may not be the sole growth stimulator present in cod liver oil.

A commercially dried liver product fails to support trout life over a 20-week period.

350. Harmic, Jay L. 1955. DELAWARE LAKE AND POND SURVEY. Delaware Board of Game and Fish Commissioners, Fisheries Pub. No. 4, 56 pp.

This is the third and final publication in a series of reports of preliminary investigations, and covers 31 fishing ponds and 2 streams open to public fishing in Delaware. In addition, six private fishing areas are considered. The present condition of each pond is discussed and recommendations made as to remedial measures needed to increase the fishing potential of each area. For each body of water similar information is given including a small contour map showing access areas, piers, pond acreage, area drained, and owner, and a brief description of the vegetation, fisherman facilities, water level control structures, and the type and quality of fishing offered.

351. May, Otho D., Jr. 1955. EXPERIMENTS WITH COMMERCIAL FISHING TRAPS IN THE OCONEE, OCMULGEE AND ALTAMAH RIVERS OF GEORGIA. 11 pp. pamphlet issued by Georgia Game and Fish Commission.

During a two-year trapping program under Georgia's Federal Aid Project F-1-R-3 efforts were made to correlate the catch with physical changes in the above streams. This study was undertaken to determine the present species composition of a sample area and to establish the most desirable means of managing the area for increased production of a sport fish population. Observations indicated that water level and temperature had a relationship with the catch. A marked increase in the catch occurred during periods of rising water until water overflowed the banks, following which there was a marked decline in the take. The catch in water below 48° F. was insignificant. For each degree increase above 48° F. there was an increase in the catch per unit of effort until the water temperature reached a point between 84° F. and 87° F. Above this point, an increase in temperature showed a corresponding decrease in the catch per unit of effort.

The paper includes a description of the study area, types of gear used for trapping with illustration, methods and baits used, effect of depth and bottom type on catch, an analysis of the composition of catch and a discussion of the comparable effectiveness of the traps used.

352. Frost, Winifred E. 1954. THE FOOD OF PIKE, ESOX LUCIUS L., IN WINDERMERE. Jrnl. of Animal Ecology, Vol. 23, No. 2, November, pp. 339-360.

The present paper gives the results obtained from the examination of some 3,000 fish from 1.5 to 105 cm. long, caught from 1940 to 1953, and deals with the food and feeding habits of the pike and the relationship of these to other fish in the lake. The pike examined were caught by standard seine, minnow seine, gill-nets and hand-net.

Of the small pike (20 cm. and less) those of 10.5—17.5 mm. feed entirely on Entomostraca, those of 35—200 mm. chiefly on fish, mainly perch fry of 10-60 mm., and to some extent on aquatic insect larvae and Eurycercus lamellatus. Large pike (of 20—105 cm.) feed almost entirely on fish, perch and trout predominantly, char considerably, and stickleback and minnow to some extent; pike and eels are of no consequence.

Predation on fish shows seasonal fluctuations in intensity. Perch occur in the diet at all times but predominate from May to October; char are eaten only in November and December; trout are eaten to a greater extent from October to February; sticklebacks and minnows are eaten in spring and summer. Such seasonal variations are associated with the changes in habit of the food species.

Increase in the size of the pike is associated with increase in size of the food organisms eaten. Among pike of 1.05—20 cm. this is effected by a change in the kind of food, from Entomostraca to perch fry; among pike of 20—105 cm. there is a change (1) of the fish species eaten, (2) of the size of individuals of a particular species. The pike selects the larger and older individuals of the perch and trout populations in the lake. The 83 percent of small pike with food in their stomachs compared with 52 percent for large pike is probably associated with the difference in size of food animals eaten by them. Among large pike a decrease in the proportion of feeding fish corresponds to an increase in size of the pike. The lowest percentage of feeding fish is found about spawning time, the highest after this time.

Comparison of the fish eaten by the pike with those present in the lake leads to the conclusion that abundance and availability rather than selection by the pike determine the species eaten (with the possible exception of sticklebacks). The feeding habits of the pike have a marked effect on the survival of fish in Windermere Lake and so affect the numbers of the species and the structure of their populations,

as demonstrated for the perch, trout and char.

353. Moore, W. H. and C. H. Mortimer. 1954. A PORTABLE INSTRUMENT FOR THE LOCATION OF SUBCUTANEOUS FISH-TAGS. Extrait du Journal du Conseil International pour L'Exploration de la Mer, Vol. 20, No. 1, 4 pp.

Methods of detection of metal fish-tags or of metal impurities in foodstuffs are well known. Our problem was to construct a simple, portable instrument, using available (mainly war surplus) components. The instrument had to be sufficiently robust and weatherproof for use during netting operations in the field, and capable of detecting small metal tags of the type described in the paper of LeCren, "A Subcutaneous Tag for Fish," 1954, even when embedded several millimetres below the skin of a fish. It was found possible to do this with tags of Monel metal of the dimensions 15 x 4 x 0.25 mm., the ferromagnetic properties of which rendered detection easier than when other metals, such as silver, were used. The instrument is of conventional design and the brief description given here should be adequate to enable those with some knowledge of electronics to construct a similar device.

354. Moore, W. H. 1954. A NEW TYPE OF ELECTRICAL FISH-CATCHER. Jrnl. of Animal Ecology, Vol. 23, No. 2, November, pp. 373-375.

This equipment is designed for hill rivers and streams where access is difficult and the fish small. It has been used since November 1953 and has proven satisfactory. It utilizes a free running saw-tooth oscillator consisting of a mercury-vapour thyratron with an inductive and capacitive network producing 20 pulses/sec. At this pulsing rate, pulses last for 10 millesecond with a space of 40 millesecond. The peak voltage appearing across the electrodes, when immersed in water, is approximately 500 v., and rises to 110 v. when electrodes are an open-circuit. A circuit diagram is provided together with a parts list.

355. LeCren, E. D. 1955. YEAR TO YEAR VARIATION IN THE YEAR-CLASS STRENGTH OF PERCA FLUVIATILIS. Proceedings of the International Assoc. of Theoretical and Applied Limnology, Vol. 12, pp. 187-192.

Year-class strength of yellow perch in Lake Windermere (England) was determined for each year from 1940 through 1951. Strength of the year classes for 1940 to 1945 fell, was very weak in 1946, 1947, 1948 and 1950, but in 1949 it was exceedingly stronger than preceding or succeeding years. For example, it was 30 times larger than the 1948 year-class. Data available permitted calculation of egg production for a year-class and with the figures on catches of resulting fish three years later, the relative survival rate for each year-class in its first 3-years of life could be estimated. The strong year-class of 1949 coincides with a high survival rate; it was derived from a very low egg production.

Preliminary results from collections made in 1953 in a number of other lakes suggest that similar and synchronous variations in year-class strength occurred in these lakes. The 1949 year-class is prominent on all and dominant in the majority of them. These variations can only be the result of variations in survival not in egg production. It is of distinct interest to note that the lakes sampled range from oligotrophic to fairly eutropic, thereby suggesting that some climatic factor is responsible.

356. Frost, Winifred E. 1955. AN HISTORICAL ACCOUNT OF THE CHAR IN WINDERMERE. The Salmon and Trout Magazine, January, pp. 15-24.

The breeding habits of the char (S. willughbii) in Windermere Lake are extraordinary in that there are two distinct populations of breeding fish, there are those char which spawn in the autumn (November-December) and those which spawn in the spring (February-March). The autumn spawners lay their eggs on the shore of the lake in shallow water (3 to 12 feet) where the bottom is of coarse sand, gravel, and larger stones; there are several such spawning grounds round the shores. The eggs are found among the stones, apparently having been dropped down among them, but the possibility that nests are made in the fine gravel cannot be ignored. At the same time, November and December, char enter the River Brathay, the main inflowing stream of Windermere, and spawning takes place about half a mile up the river; the eggs are found among the stones and gravel as on the lake shore. The spring spawners breed only in the lake where, in February and March, the eggs are laid fairly close inshore but at a depth of 60 to 80 feet. Several of these spring breeding grounds are known in Windermere. The two breeding types keep their identity since tagging experiments have shown that the char which breed in the autumn on the shallow grounds retain the same habit at each year's subsequent spawning and that those char breeding in the spring in deep water also retain their particular breeding behaviour.

These fish of such different breeding habits show no morphological differences, they differ only in colour, size and rate of growth. The spring spawners are mostly larger than the autumn breeders and their growth, after the third year is slightly faster than that of the autumn fish. The char of these two populations because they occur in the same body of water and as they have similar morphological features but possess specific biological characteristics (growth rate and breeding habit) and are reproductively isolated may be defined as sibling species. The char in Windermere are an example of sympatric speciation, a phenomenon which has been recorded for other genera of fish in various fresh waters of the world.

357. LeCren, E. D. 1954. A SUBCUTANEOUS TAG FOR FISH. Extrait du Journal du Conseil International Pour L'Exploration de la Mer, Vol. 20, No. 1, 11 pp.

Over the winter of 1949-50, char were marked with several different tags and fin clips. The state of the marks and the survival of the fish were observed when the ponds in which they were kept were drained. As single subcutaneous tags and clipped

anal and pelvic fins showed the most promise, further experiments were concentrated on these.

The tag used was a flat slip of Monel metal 15 mm. by 4 mm. cut from metal 0.254 mm. thick; corners were rounded. After a small verticle slit had been made with a scalpel, and the skin was lifted from the flesh, the tag was inserted with a fingernail. The tag may be removed upon recapture, the number read and the tag reinserted and the fish released.

Sufficient evidence has been collected over a long enough period to show that the tagging could not have had any great effect upon the survival, growth, and general health of the fish, though such a conclusion is to some extent still tentative. Rates of recapture were more than adequate to provide most of the information sought by the marking experiments, and the method was more satisfactory in this respect than any other previously tried. As a result of several field experiments, returns of up to 29 percent were obtained after one year and smaller percentages after two and three years' absence. The rate of loss of tags was higher than desirable, 20 percent, but as tagging was used in conjunction with fin clipping not all information was lost. As tags were easily detected, use of a magnetic or metallic material capable of electronic detection does not seem necessary. Some slightly different tag is needed for small char and trout.

358. Bishop, Clinton G. 1955. AGE, GROWTH AND CONDITION OF TROUT IN PRICKLEY PEAR CREEK, MONTANA. Trans. of the American Microscopical Soc., Vol. 74, No. 2, April, pp. 134-145.

An intensive trout population study made on Prickley Pear Creek, Montana, during the summers of 1949, 1950 and continued in 1951, provided an unusual opportunity to collect trout for age, growth, and condition in relation to population changes during the three years. The samples collected represent near total populations for the sections covered.

Prickley Pear Creek is 23 miles long; it flows in a northeasterly direction and enters the Missouri River six miles upstream from Craig, Montana. The lower 13 miles, from which samples were taken, varies in width from 15 to 60 feet, with a maximum depth of 8 feet, and a fall of approximately 41 feet per mile.

Brown trout was the most numerous salmonid followed by rainbow trout. Small numbers of eastern brook trout and only one cutthroat trout were found. Mountain whitefish, though never abundant, were most numerous in the spring. The longnose sucker was abundant especially in spring and early summer. A few western white suckers, carp and burbot were present. Fresh water sculpin was abundant at all times.

Fish were taken by the electric shock method from six 600-foot sections. Nine collections were made as follows: four in 1949, three in 1950 (part of one section was shocked a fourth time), and two in 1951. Captured fish were anesthetized in urethane. Total lengths were measured to the nearest 0.1 inch and weights to the nearest 0.02 pound. All fish were marked and released. No scale samples from recaptured or hatchery fish were used in this study since growth may have been affected by handling and tagging.

Scales were taken from either the right or left side between the dorsal fin and lateral line. Scale measurements were made from the center of the focus along the median anterior radius. A constant ratio of length of scale radius to body length was assumed. Scales from 1,285 brown trout, 866 rainbow trout, and 127 eastern brook trout were studied.

Comparison of the average length at capture for each age group with the length-frequency modes determined for these trout by Frank A. Stefanich in his 1952 studies revealed good agreement with the outstanding peaks in the length distributions.

The grand average calculated lengths for brown trout at annulus formation for years 1-5 were: 3.8, 7.7, 11.1, 13.7, and 16.5 inches. The legal length of 7 inches was reached in the second year. Growth was greatest in the second year and dropped sharply in the fourth year.

The grand average calculated lengths for rainbow trout at annulus formation for years 1-4 were: 3.5, 6.6, 9.4, and 11.8 inches. Legal length was not reached until the third year. Growth rate was greatest in the first year and declined gradually through the third year.

The grand average calculated lengths for brook trout at annulus formation for years 1-3 were: 4.1, 7.0, and 9.6 inches. Legal length was reached in the second year as in the brown trout. Growth was slightly better than for rainbow trout but less than for brown trout. First-year brook trout were larger than either rainbow trout or brown trout, probably because of earlier hatching.

Coefficient of condition (C) remained approximately the same for each species of trout throughout years 1-4. Values for rainbow trout averaged 39.5 (range 35.6-41.4); the highest for the three species. Brook trout had the lowest coefficient of condition with an average of 37.5 (range 33.9-40.1). The values for brown trout averaged 37.7 (range 35.3-39.6).

359. Miller, Daniel J. 1955. STUDIES RELATING TO THE VALIDITY OF THE SCALE METHOD FOR AGE DETERMINATION OF THE NORTHERN ANCHOVY (ENGRAULIS MORDAX). Calif. Dept. of Fish and Game, Marine Fisheries Br., Fish Bulletin No. 101, pp. 6-34.

Otoliths and skeletal structures were of little aid in age determinations of the northern anchovy. Scales mounted dry between two glass slides proved satisfactory and could be routinely handled and read in a manner similar to the method adopted for the Pacific sardine.

The percentage of first disagreements between readers was high. About one-half of the scales read were doubtful on the first reading, but subsequent readings tended to limit the number of second disagreements. The percentage of disagreements

on anchovy scales was comparable with that on the Pacific sardine scales read by the same scale readers during the same period.

Calculated lengths for the first year agreed with observed lengths for year-old fish. There were no differential growth rates between scales from different parts of the body and the scale length-fish length increments were directly proportional for fish larger than 45 mm. standard length. Corrections of calculated lengths are needed if they are below 45 mm.

The annual rings were formed during the early winter and spring months and all fish showed new rings by the middle of April. Growth rates decreased during late summer and fall, August through November.

Schooling behavior and economic desirability of larger fishes was responsible for the differences between observed and calculated lengths of the 1952 year class in Southern California.

The growth trend of fish in their first year as determined by length frequencies substantiated the age readings.

360. Hubbs, Clark. 1955. THE YELLOW PERCH INVADES TEXAS. Texas Game and Fish, February, pp. 17 and 27.

The yellow perch is a native of the quiet waters in north-central and eastern United States, as well as central Canada. It has been introduced throughout the United States, and most of its introductions into the south-central states have been unsuccessful. All in Texas have failed, but introductions into the western states have met with better success.

All of the Pacific Coast states, for instance, have populations of yellow perch although it is not native west of the Continental Divide. One of the successful western introductions was that in the New Mexican reservoirs on the Rio Grande. It might be expected that some of the offspring from these fish would swim downstream into Texas. This possibility was confirmed on June 12, 1954, by the capture of one young yellow perch in the Rio Grande nine miles northwest of El Paso.

It is not believed that this new addition to the Texas fauna will affect fishing in the State. The segment of the Rio Grande northwest of El Paso is isolated from other fresh waters by many miles of dry channel. During dry seasons, the Rio Grande does not flow between El Paso and Presidio and over much of this distance, there are no pools in the channel. Even if this species were to navigate this stretch during high water, its spread in Texas is doubtful.

361. Kerswill, C. J. and P. F. Elson. 1955. PRELIMINARY OBSERVATIONS ON EFFECTS OF 1954 DDT SPRAYING ON MIRAMICHI SALMON STOCKS. Progress Rpts. of the Atlantic Coast Stations, No. 62, July, 43 pp.

Recently new information has come to light about the harmful effects of forest spraying on young salmon in New Brunswick streams. The forests of New Brunswick and the Gaspe peninsula are now suffering from a severe outbreak of the spruce budworm. This insect pest feeds mostly on the needles of balsam fir and spruce, and can kill trees of all ages. In 1952 the lumber industry started to control the insect and save the trees in northern New Brunswick by spraying the woods with DDT insecticide from aircraft. In 1953 and 1954 the insecticide was applied at the rate of 1/2 pound of DDT per acre.

In June 1954, the million acres in New Brunswick which were sprayed with insecticide included about one-third of the watershed of the Miramichi River. This gave the first opportunity for anyone to study the effects of DDT on stocks of Atlantic salmon which had been under close observation before spraying.

Fortunately, a study was started in 1950 of the numbers of young salmon found each year in two tributaries of the Miramichi River system. Data were available also on the numbers of adult salmon entering these tributaries since that time. The numbers found before spraying, when compared with those found after spraying, provide the most valuable information on the effects of DDT on salmon.

Additional information on the effects of DDT was sought by holding young salmon in cages both inside and outside the sprayed area, by patrolling waters over a wide area for signs of dead or distressed fish, and by checking on the survival of aquatic insects which are the main food of young salmon.

The most drastic reduction was in the fish that hatched in the spring of 1954 (fingerlings), none of these being found in the Northwest Miramichi and virtually none in the Dungarvon areas. In the Dungarvon these young-of-the-year were so scarce that on the average only one was found for every 300 square yards of stream bottom examined.

Young native salmon were held in 14 cages that were set out in the streams before the start of spraying. Each cage was 6 feet long, 3 feet wide and 2 1/2 feet high, with solid wooden sides, ends of closely spaced steel rods, and screened top and bottom. The sites were selected, from a plan of the proposed spraying, to include some well inside the sprayed area, some below the area but in water draining it, and some well outside the area as controls. The actual spraying was not carried out exactly as planned, so all the cages were not subjected to the expected conditions.

At each of the three affected places two cages were held, one with 50 parr and the other with 25 parr. At the unaffected place one cage was held, with 50 parr. The fish for all cages were selected at random from a large group ranging in length from 2 3/4 to 4 1/4 inches. They were examined at frequent intervals, usually daily.

The date of spraying depended on the stage of development of the local budworms, and adjacent blocks were sometimes sprayed on widely separated dates, up to 2 or 3 weeks apart. Thus, it is impossible to state exactly which sprayings were responsible for particular deaths of fish. Usually, however, sizable groups of fish died within a few

days of spraying over extensive areas upstream from the cages. Initial spraying over the cages but not far upstream from them had no apparent effect on the fish, possibly because the insecticide was carried away at the surface before there was a chance for it to become mixed with deeper water.

Frequent patrolling of streams both inside and outside the sprayed area and of Peabody Lake in the sprayed North Branch Sevogle area showed that many fish were killed in the sprayed streams but that there were no unusual deaths in unsprayed streams or in the lake.

The aquatic insects on which the young salmon feed have also been cut down to very low numbers.

362. Hubbs, Clark and William F. Herzog. 1955. THE DISTRIBUTION OF THE SUCKERMOUTH MINNOW, PHENACOBIUS MIRABILIS, IN TEXAS. The Texas Jrnl. of Sci., Vol. 7, No. 1, March, pp. 69-71.

The suckermouth minnow, Phenacobius mirabilis (Girard), has been known to occur in the coastal streams of Texas since Jordan and Gilbert's (1886) records from the Sabine River at Longview and the Trinity River at Dallas. Although many subsequent authors have mentioned the occurrence of this fish in the State, only Evermann (1892) has listed a supplementary locality, i.e., the Trinity River at Magnolia Point, 10 miles southwest of Palestine.

Three records of the suckermouth minnow are now available from the Colorado River System. Recently four other cyprinids have been added to the known fauna of the Colorado River by Jurgens (1954), who felt that all four had been recently introduced as bait. Although some or all of those minnows may have been introduced, it is felt that of these only Semotilus is not native to the Colorado River System. All of the others have established populations in the River.

The suckermouth minnow is believed to have a natural distribution typical of many fresh water fishes. The southwestern limit to its range is along the Balcones Escarpment. Thus, water chemistry rather than stream divides appears to be the major barrier to its southwestern distribution.

363. Sublette, James E. 1955. THE PHYSICO-CHEMICAL AND BIOLOGICAL FEATURES OF LAKE TEXOMA (DENISON RESERVOIR), OKLAHOMA AND TEXAS: A PRELIMINARY STUDY. Texas Jrnl. of Sci., Vol. 7, No. 2, June, pp. 164-182.

The physico-chemical limnology of Lake Texoma, Oklahoma and Texas, is presented together with lists of planktonic and macrobenthic organisms. The study period was June and July 1949, and June 1950 to May 1951. Most of the physico-chemical data were taken in 1949.

364. Hubbs, Clark. 1955. KEY TO THE FRESH WATER FISHES OF TEXAS. February 22, 30 pp., mimeo.

A taxonomic key to the families and species of fish found in the fresh waters of Texas is presented. A total of 42 families are reported.

365. Finnell, Joe C. 1954. VARIOUS BIOLOGICAL, CHEMICAL, AND PHYSICAL ASPECTS OF PRYOR CREEK RESULTING FROM POLLUTION DURING THE SUMMER OF 1954. Mimeo. pamphlet published by Okla. Game and Fish Dept., Sept. 24, 32 pp.

Field and laboratory studies were conducted during June, July, and August 1954, on Pryor Creek, a small northeastern Oklahoma stream affected by both municipal and industrial effluents of predominately organic composition. In Pryor Creek and other streams of intermittent flow, unfortunately, the decay of these materials is most rapid at high water temperatures, a situation which coincides with their period of seasonally low stream flows.

Pryor Creek receives pollutants from several sources. The major contributors during the time of this survey were a sewage treatment plant, a paper company, and a gypsum company.

The studies were conducted to determine existing stream conditions with special reference to the added effect of white water from the paper mill machines.

Sampling stations were selected along Pryor Creek above and below the entrances of waste carrying tributaries. Eight stations were chosen on the basis of desirable location and accessibility for sampling. At each of these stations samples of water were obtained and the following determinations were made: temperature, pH, dissolved oxygen, and biochemical oxygen demand (B.O.D.). Plankton was collected by means of a Wisconsin plankton net, concentrated in about 25 milliliters of H_2O, and preserved for identification in 4 percent formalin (a few live samples were used to help in identification.) Bottom samples of mud and gravel were collected with an Ekman dredge and examined for bottom-living organisms. In addition, observations were also made of organisms living on rocks, etc., conditions of the bottom of the stream, appearance of water, and other physical aspects of the stream and its environs.

Though no fish kill was noticed at the mouth of the creek during the summer, such an occurence is quite likely on occasion. It is doubtful that Pryor Creek will ever have the capacity to effectively maintain a healthy and abundant fauna and flora under average stream flow conditions with the present pollutant load.

Eight tables give the physical and chemical data obtained at each sampling station, while 8 others present plankton and bottom organisms sampled. Each station is discussed separately.

366. Hennemuth, Richard C. 1955. GROWTH OF CRAPPIES, BLUEGILL, AND WARMOUTH IN LAKE AHQUABI, IOWA. Iowa State College Jrnl. of Sci., Vol. 30, No. 1, August 15, pp. 119-137.

Fishery investigations were started on Lake Ahquabi in the fall of 1952, continuing over August and September 1952, and June, July, and August 1953, to determine what possible changes in the fish

population might have accompanied the noted changes in environment.

Growth data for the white and black crappies, bluegill, and warmouth have been analyzed and are presented in the paper. A definite acceleration of growth was found to have occurred in 1952, accompanying a decrease in turbidity and increase in volume of the lake.

367. Forney, John L. 1955. LIFE HISTORY OF THE BLACK BULLHEAD, AMEIURUS MELAS (RAFINESQUE), OF CLEAR LAKE, IOWA. Iowa State College Jrnl. of Sci., Vol. 30, No. 1, August 15, pp. 145-162.

Data on black bullheads were collected at Clear Lake by the Iowa Cooperative Fisheries Research Unit in 1943 and 1947 to 1954, but principal emphasis was placed upon this species in 1951. Young-of-the-year bullheads were abundant around shore in 1943, 1945, 1946, 1947, 1951, 1952, 1953 and 1954. No young bullheads were seen in 1948 and 1949 and only a few in 1950. Possibly the scarcity of aquatic vegetation in the lake in 1948 to 1950 affected reproduction and survival.

Markings on the vertebral centra collected in 1950, 1951, and 1952 indicated that all the adult bullheads at that time belonged to the 1946 year class, except for a few older fish collected in 1950. Sections of the dorsal spine showed similar markings, but thickening of the central portions of the opercula prevented the use of the latter structure for age determination. The 1946 year class showed rapid growth in 1951 but slow growth from 1948 through 1950 and 1952 through 1954.

In 1951, bullheads of Ventura Marsh, of the east end, and of the west end of the lake differed in growth and in length-weight relationships. The Ventura Marsh bullheads decreased in condition throughout the summer, grew slowly, and were heavily infested with Clinostomum complanatum.

The 1951, 1952 and 1953 year classes began to support the angling in 1953, whereas the 1946 year class alone had supported the fishery for about 3 years.

Food of the adult bullheads was predominately chironomid larvae in 1951. Small young-of-the-year bullheads fed exclusively upon entomostraca, but as their size increased, insect larvae became increasingly important in their diet.

Of the five species of internal worm parasites identified from Clear Lake bullheads, only Clinostomum complanatum appeared to have a significant effect on growth or survival.

Ovaries of 41 female bullheads each contained 3,000 to 4,000 eggs. Late fall and winter appeared to be the critical period in survival of the young bullheads of the 1951 year class. Predation had little effect, at least during the summer of 1951.

368. Peterson, Lawrence W. 1955. WINTER FISHERIES INVESTIGATION ON BUFFALO BILL RESERVOIR, 1955. Fisheries Technical Rpt. No. 1, Wyo. Game and Fish Comm., July, 21 pp., mimeo.

A winter fishery study was conducted on Buffalo Bill Reservoir, Park County, Wyoming, between January 20 and March 31, 1955. During the 71-day creel census period the estimated utilization of the reservoir was 1,661 fisherman-trips, and the estimated harvest was 2,780 game fish weighing 3,337 pounds. This is approximately 0.9 of a pound per acre.

The predominant species in the catch was cutthroat trout (38 percent by number and weight) followed in weight by rainbow trout (21 percent), brown trout (20 percent), lake trout (19 percent), hybrid (cutthroat x rainbow) trout (1.6 percent), and mountain white fish (0.4 percent).

Average success was 0.31 game fish (99.7 percent trout) per hour for a 5.55-hour day, or 1.7 fish per trip.

The average lengths of the fish in the catch were: cutthroat trout - 15.5 inches, rainbow trout - 15.3 inches, brown trout - 16.2 inches, lake trout - 17.5 inches, hybrid (rainbow x cutthroat) trout - 15.2 inches, and mountain whitefish - 17.0 inches. Brown trout were in notably poorer condition than cutthroat or rainbow trout.

A comparison of the creel census data for the winter of 1955 with that from winter of 1953 indicates the catch per hour was about the same. Cutthroat made up a smaller portion of the catch in 1955 than in 1953; brown trout made up a larger portion. Average sizes of fish creeled were about the same both years except brown and lake trout averaged somewhat longer in 1955.

Mountain whitefish and all species of trout were found to be feeding primarily on zooplankton.

Two series of gill net sets were made. One series of 15 exploratory gill-net sets in areas representative of the entire reservoir yielded a catch ratio of 1 trout to every 0.7 non-game fish. The other series of 10 net sets in a limited area yielded a catch ratio of 1 trout to every 3.6 non-game fish.

369. Hildebrand, Henry H. 1954. A STUDY OF THE FAUNA OF THE BROWN SHRIMP (PENAEUS AZTECUS IVES) GROUNDS IN THE WESTERN GULF OF MEXICO. Publ. of the Institute of Marine Sci., Vol. 3, No. 2, Nov., 366 pp.

Between October 20, 1950, and August 8, 1951, the bottom fauna on the shrimp beds in the western Gulf of Mexico were studied, as sampled by the trawls of the shrimping fleet. Specimens were identified and counted at sea and some were brought ashore for further study. A total of 430,000 fishes and 1,749,000 invertebrates was counted. These included 157 species of fishes, 104 invertebrates and two ascidians. A large number of species new to the Mexican coast were recorded and nine fishes and ten invertebrates new to the western Gulf were recorded.

The four major grounds for the brown shrimp and the pink shrimp grounds in the Gulf of Campeche are for the first time delineated and described. The faunal complex or bottom communities on brown shrimp beds are described and have been given community designations in terms of the most abundant animals caught. Additionally, the comparative or relative abundance of all species of fishes and in-

vertebrates on each ground is more extensively discussed and compared with the inshore fauna.

Each species taken is discussed individually and various natural history notes, including bathymetric distribution, are given.

Data were gathered on quantitative distribution of white and brown shrimp by number and pounds per acre of bottom trawled. It is clear that the brown shrimp do not "school" extensively while the white shrimp do. The range for brown shrimp was 7.3 to 1.1 pounds per acre while the greatest range for white shrimp during a poor season was 5.4 to 1.6 pounds per acre. A break-down of the number of species caught shows that the greatest numbers were taken at depths of 12 to 25 fathoms rather than at depths of 0 to 12 fathoms.

370. Rupp, Robert S. 1955. STUDIES OF THE EASTERN BROOK TROUT POPULATION AND FISHERY IN SUNKHAZE STREAM, MAINE. Jrnl. of Wildlife Mgt., Vol. 19, No. 3, pp. 336-345.

A virtually complete creel census in 1949 and partial creel censuses in 1951 and 1952 allowed an analysis of the eastern brook trout (Salvelinus fontinalis Mitchill) fishery and population of a limited section of Sunkhaze Stream, Maine. Creel census data showed a general improvement in the fishery during the four-year interval 1949 through 1952. It is postulated that the improvement was the result of more favorable weather and water conditions after 1949. Stocking was not involved in the change since liberation of hatchery-reared trout was discontinued in 1950. Population analyses made from samples collected through creel census showed growth rates, average sizes, condition factors, and survival rates favorably comparable with similar measures obtained by other workers on other eastern and northern trout streams. It was concluded that the present fishing intensity is not endangering the continued natural maintenance of the trout population. (A)

371. Spindler, John C. 1955. LOSS OF GAME FISH IN RELATION TO PHYSICAL CHARACTERISTICS OF IRRIGATION-CANAL INTAKES. Jrnl. Wildife Mgt., Vol. 19, No. 3, pp. 375-382.

The relationship between legal game fish loss and various physical characteristics of canal intakes was investigated on twelve irrigation diversions of the West Gallatin River, Montana, during the summers of 1951 and 1952. The physical characteristics considered were: Headgate location, construction, and manipulation; intake velocity, volume, gradient, width, depth, and angle with river; location of intake in relation to river flow, amount of water diverted in comparison to the amount retained by the river, diversion dams, bottom types, and cover. No correlation was apparent between legal game fish loss and location, construction or manipulation of headgates and the linear regression of fish loss on velocity, gradient, width, or depth of intakes did not prove significant by the analysis of variance test. The regression of fish loss on the angle of the intake with the river or the amount of cover at the intake and adjacent river area did not prove significant and bottom types in the intake and adjacent river areas or the existence of diversion dams at the intake had no observable influence on fish loss. Legal game fish loss was highest in canals with the higher volumes of flow and in those with intakes on river bends and the highest loss in 1952 was sustained by a canal into which all but a negligible amount of water was diverted from the river. (A)

372. Lewis, William M. 1955. THE FISH POPULATION OF THE MAIN STREAM OF THE BIG MUDDY RIVER. Ill. Academy of Sci. Trans., Vol. 47, pp. 20-24.

The Big Muddy River is one of the principal tributaries of the Mississippi River in Illinois. The river's basin extends 105 miles from north to south, 70 miles from east to west, and covers an area of 2,360 square miles. Water level fluctuations amount to as much as 20 to 30 feet. High waters on the Mississippi frequently cause a reversal of current in the Big Muddy as far up stream as 40 miles. The river channel throughout most of its course is 20 to 50 feet wide and 50 to 70 feet deep. The banks are almost entirely mud.

Walker (1952) investigated the river's physico-chemical characteristics. His findings showed the chemical conditions of the Big Muddy were usually above the minimum requirements for fish. The occurrence of obviously toxic pollution was spasmodic and localized. The major pollutants were sewage, creosols, silt, garbage wastes, iron and other coal mine wastes.

Schuster (1953) investigated the water quality of the river. Bacterial counts indicated some degree of sewage pollution. The B.O.D. values of the waters sampled fell within normal limits. The D.O. content was always above a critical minimum. The chloride content of the Pond Creek tributary was unusually high for the locality, and was the cause of higher than normal values in the Big Muddy River. The hydrogen ion concentration indicated a slightly alkaline condition during the low water stages, and slightly acid one at the high water stages.

The ionic content of the waters sampled was mainly chlorides. Turbidity values averaged moderately low; and water temperatures closely followed the air temperatures.

On February 11, 1954, personnel from the Southern Illinois University fish laboratory sampled Crab Orchard Creek above and below the effluence of Piles Fork, a tributary draining a tie plant located on the watershed of Crab Orchard Creek. There was found to be an abundance of fish one-quarter of a mile above the effluence, but none at or below it for a distance of approximately three miles. This creosote pollution is probably more important than it might appear. The creosote accumulates in the tie storage area and is washed into the river during rainy periods. Hence the concentration of the material in the river varies.

Three methods were utilized to sample the fish population. (1) During April and May 1951, one man fished more or less continuously with two wing nets.

He also ran catfish baskets occasionally. The nets were set parallel to the bank and were lifted at 3-day intervals. (2) During the period August 22 to October 16, 1951, intensive sampling was done with an electric shocker. Electrical sampling was also carried out during the period May 25 to July 13, 1953. (3) During October 1953, a series of seine samples was taken.

Water level fluctuations have a pronounced effect upon the capture of fish by the methods used. In the case of the Big Muddy, high water was conducive to higher catches in hoopnets but lower catches by electrical shock. Seining was possible only at very low water stages. The methods of catch are selective.

The European carp, largemouth buffalo, smallmouth buffalo, and fresh water drum are abundant in the Big Muddy and dominate the river's fish population. The result is that the majority of the fishing in the river is of a commercial nature. It is of interest that the commercial catch, which is made primarily by hoopnets, is best during high water.

The steel-colored minnow is the only bait species abundant enough to be of any interest, and it is not available except during low water. The white crappie is the only species abundant enough to support any significant amount of recreational fishing. Other game fish caught in the river are: black crappie, yellow bass, white bass, bluegill, warmouth, largemouth bass, eastern sauger and walleye.

Both the longnose and shortnose gars are abundant in the river and are highly efficient predators. It is likely that the river possesses a gar-shad economy which is independent of a carp and catostomid-invertebrate economy.

373. Durham, Leonard. 1955. ECOLOGICAL FACTORS AFFECTING THE GROWTH OF SMALLMOUTH BASS AND LONGEAR SUNFISH IN JORDAN CREEK, ILLINOIS. Ill. Academy of Sci. Trans., Vol. 47, April, pp. 25-34.

The portion of Jordan Creek which was studied consisted of the lower four miles of the stream. This study area is divided into an unshaded upstream area and a shaded downstream area.

The mean daily water temperatures in the upstream area were higher than those in the downstream area during the summer months of 1951. Greater extremes of water temperatures occurred in the upstream area.

Samples of bottom fauna in 1952 revealed that in June there were slightly more annelids, insects, and mollusks in the lower area of the stream than in the upstream area. There were about two times as many crayfish in the lower area as in the upper area, but in July, August, and September, there were always at least twice as many bottom invertebrates in the collections from the upstream area as in those from the downstream area.

Smallmouth bass grew faster in the upper open area of the stream than in the lower wooded area. There were 27 percent more bass downstream in 1950, and collectively they weighed twice as much as the bass upstream.

Longear sunfish grew at almost the same rate upstream as downstream. There were almost four times the number and twice the weight of longears upstream as downstream in 1950.

The faster growth rate of bass in the upstream area of Jordan Creek may be the result of warmer temperatures, more bottom organisms, less interspecific crowding, and greater numbers of minnows. The possible advantages of warmer temperatures and more bottom invertebrates are not reflected in growth of longear sunfish in the upstream area possibly because of increased inter- and intraspecific competition.

374. Yashouv (Wirszubski), A. 1955. FILAMENTOUS ALGAE IN FISH PONDS. Bamidgeh, Bull. of Fish Culture in Israel, Vol. 7, No. 1, pp. 10-12.

Under conditions existing in Israel, it seems difficult to control the filamentous algae covering the bottoms of ponds, with stimulation of water bloom by fertilization. Phosphorus and nitrogen were taken up faster by the filamentous algae than by the water bloom algae. Therefore, control of filamentous algae was attempted by spraying a solution of sodium arsenite at a rate of 10 p.p.m. of AS_2O_3 (1 ounce per 100 cubic feet). This produced desirable results, increased the phosphorus up to 7-8 mg/liter of water and had no harmful effect for the adult and fry of Tilapia galilaca. (S.F.S.)

375. Lennon, R. E. TOXICITY TESTS. Natl. Acad. of Sci., Natl. Res. Council, summary of tables of biological tests, Chemical-Biological Coord. Center, Vol. 6 (1954), No. 3, pp. 186-212; No. 5, pp. 360-372; Vol. 7 (1955), No. 2, pp. 213-265; No. 3, pp. 400-412.

A series of chemical compounds was selected on the basis of structure, solubility, and availability by the Chemical-Biological Coordination Center and furnished to the Fish and Wildlife Service at Kearneysville, West Virginia, for screening tests with fish.

Brown trout (Salmo trutta), bluegill (Lepomis macrochirus), yellow perch (Perca flavescens) and goldfish (Carassius auratus) were placed in aerated, constant temperature aquaria containing the test compound at 5 p.p.m. by weight, in a suitable emulsifying or dispersing agent if the compound was not easily soluble in water or other common solvents. The time to cause sickness or death in the fish is indicated in hours. The results obtained with 735 compounds are given in volumes listed above. Chemicals are listed in style of nomenclature prescribed by CHEMICAL ABSTRACTS. Structural formulae are included. (A)

376. Vibert, R. 1954. L'AMENAGEMENT DES EAUX DOUCES ET LA RECHERCHE PISCICOLE. (The Management of Freshwaters and Fishery Research.) Conseil Superieur de la Peche, Paris, 49 pp.

The fishery Research Service was established in 1949 to study conditions for the improvement of fish productivity in fresh waters. A survey was

made of world-wide literature on the management of freshwaters. In 1952, a 3-month tour was made of important fishery research centers in the United States and Canada to observe the results of a half-century of progress in fish management.

This account presents a resume of the ideas which have evolved in the field of fish management. It is concerned more with American, Canadian, English, New Zealand, Russian and Scandinavian research than with that of Central European countries where research studies have been confined mostly to lakes. The great majority of licensed fishermen in France fish the rivers, hence it is necessary that the fishery resource be protected from abusive exploitation and be managed for the benefit of the sport fishermen.

Four main topics are discussed, with emphasis on salmonid fishes: a review of general information concerning rates of survival and mortality in nature, factors of productivity, law of minimum, and degrees of exploitation; special techniques in fishery biology and management of freshwaters; possible benefits from management activities; and the place of research in freshwater fishery management. (R.E.L.)

377. Shilo, Moshe, S. Sarig, Miriam Shilo and H. Zeev. 1954. CONTROL OF PRYMNESIUM PARVUM IN FISH PONDS WITH THE AID OF COPPER SULPHATE. Bamidgeh, Bulletin of Fish Culture in Israel, Vol. 6, No. 3, pp. 99-102.

Before giving the summary of this paper, an explanation should be given about the role of Prymnesium parvum in pond fish culture. This phytoflagellate produces toxin which is liberated into water and causes high and rapid losses among pond fishes. It has been found of greatest importance in ponds having brackish water as in the Low Countries of Europe and in Israel. The Shilos have isolated the toxin and developed effective methods of control. Results were published in a number of papers during the past several years. This problem is similar to that of "red tide" in the United States. See also abstract No. 119 in Vol. 1, No. 1 of the Sport Fishery Abstracts.

In this paper authors have found that copper sulphate is suitable for the control of Prymnesium parvum even where ammonium sulphate has not been effective due to low temperature or low pH. The concentration usually effective is 1.5 to 2 p.p.m. but this depends on the chemical composition of water in the treated pond. Copper sulphate has been found toxic to carp at the concentration of 10 p.p.m. Prymnesium and blue green algae are more susceptible to the action of copper sulphate than green algae, therefore this treatment, if correctly carried out, does not reduce markedly the fertility of the treated ponds. (S. F. S.)

378. Vishniac, Helen S. 1955. THE NUTRITIONAL REQUIREMENTS OF ISOLATES OF LABYRINTHULA Spp. Journal General Microbiology (British), Vol. 12, pp. 455-463.

Labyrinthula spp. is a microorganism most likely belonging to Myxomycetes. It is believed to be the causative organism of the wasting disease of eel grass Zostera marina and therefore it is of considerable practical importance. Labyrinthula grew best in a medium of which the inorganic constituents were those found in sea water. All are obligately marine. The less exacting requirements of L. macrocystis var. atlantica suggested an estuarine habitat. All required amino acids for normal growth and L. minuta var. atlantica required L-leucine as a growth factor. All required thiamine. Though the sea water was deficient in substances required by Labyrinthulas, their requirements could be obtained from host plants. (S.F.S.)

379. Vishniac, Helen S. 1955. THE ACTIVITY OF STEROIDS AS GROWTH FACTORS FOR A LABYRINTHULA Sp. Journal of General Microbiology (British), Vol. 12, pp. 464-472.

Further investigation of the specificity of the steroid growth factor requirement of Labyrinthula vitellina var. pacifica has provided a detailed description of the structural requirements for activity. Active compounds include sterols and products of their autoxidation; the activity of the sterols is not, however, due to autoxidation during the assay period. The data obtained circumscribe the characteristics of the essential metabolite represented by this requirement but do not identify it. (A)

380. Sukhatme, P. V., V. G. Panse and K. V. Sastry. 1955. SAMPLING TECHNIQUE FOR ESTIMATING THE CATCH OF SEA FISH IN INDIA. Rpt. of Food and Agriculture Organization of U. N. FAO/55/6/3791. mimeo. 26 pp.

An extensive discussion of a sampling method applied in the estimation of catch. Section headings are as follows: 1. The problem, 2. The sampling units, 3. Efficiency of different methods of sampling a day, 4. The choice of sampling design. Statistical aspects of the problem are discussed. This paper should be of extreme value to fisheries personnel interested in the estimation of catch. A copy was obtained by the reviewer from the senior author whose address is: Food and Agriculture Organization of the U.N., Viale delle Terme di Caracalla, Rome, Italy. The copy may be borrowed from Vincent Schultz, Dept. of Biostatistics, Johns Hopkins University, 615 No. Wolfe St., Baltimore 5, Md. Aspects of this paper have been discussed in: Sukhatme, P. V. 1954. Sampling Theory of Surveys with Applications. The Iowa State College Press, Ames, Iowa, 28, 491 pp. (V.S.)

381. Taylor, William Ralph. 1954. RECORDS OF FISHES IN THE JOHN N. LOWE COLLECTION FROM THE UPPER PENINSULA OF MICHIGAN. Misc. Pub., Museum of Zoology, Univ. of Mich., No. 87, Nov. 9, 52 pp.

One of the most extensive collections of Michigan fishes was that accumulated by the late John Nicholas Lowe. It was obtained by him during the years 1920 through 1938 and is of distributional, and perhaps historical interest. The material is chiefly from the waters of the Upper Peninsula. This publication is divided into two parts the first being a list of lo-

calities from the Upper Peninsula of Michigan from which the fish were obtained. The annotated list of the fishes includes 69 species and is from 14 of the 15 Counties in the Upper Peninsula.

382. Wood, R. D. 1954. THE CHARACEAE OF LAKE MATTAMUSKEET, NORTH CAROLINA. Jrnl. of the Elisha Mitchell Scientific Soc., Vol. 70, No. 1, June, pp. 60-74.

The represented species of Characeae are described and illustrated, and an analytical key is included. The forms found include Nitella acuminata var. Belangeri, N. tenuissima, N. hyalina, N. microcarpa, and Chara zeylanica var. zeylanica and var. inconstans.

383. Everhart, W. H., J. E. Watson and R. E. Cutting. 1955. PENOBSCOT RIVER SALMON RESTORATION. Maine Atlantic Salmon Comm. and Dept. of Inland Fish. and Game, March, 13 pp., multilith.

This report, a condensation of the study presented at a 1954 meeting of representatives from industry, sportsmen's groups, the Atlantic Salmon Commission, and the Inland Fisheries and Game Department, concludes that the Penobscot River can support runs of Atlantic salmon and resident populations of landlocked salmon and brook trout.

384. Elser, Harold J. 1954. FISHING PRESSURE AND THE HARVEST OF SPORTS-FISHES ON THE POTOMAC RIVER IN 1954. Report of the Md. Dept. of Res. and Edu., Dec., 6 pp., mimeo.

Creel-censusing for the Potomac River Survey of 1954 was carried out by pairs of interviewers, working as teams, every sixth day from June 1st through Labor Day. Each team was assigned a section of river and these sections were chosen to be as typical as possible of the fishing conditions found in their respective counties. In addition, on June 1st and July 4th, because of the expected heavy fishing pressure, six additional teams were used. A total of 10 teams covered two sections in Allegany, three in Washington, two in Frederick and three in Montgomery Counties. Fisherman counts were made in two ways: (1) ground counts and (2) airplane counts.

The Potomac is a very popular fishing river. The estimate for the 1954 season is 89,000 fishing trips. Adult males constituted 82 percent of the population, women 12 percent and children (less than 14 years) 6 percent. Of the anglers interviewed, 38 percent came from Frederick, 13 percent from Allegany, 12 percent from Montgomery and 12 percent from Washington Counties. Out-of-staters amounted to about 11 percent. The Potomac River angler spent 6.3 hours at his sport on the average trip.

The catch of fish was distributed among a greater percentage of people than is usual for Maryland waters. Only 23 percent of the fishing trips were unsuccessful; this compares favorably with the 40 to 60 percent so often found in creel-census studies. About 37 percent of the total catch was taken by 10 percent of the fishermen, and 63 percent was taken by 67 percent.

The Potomac angler caught 2.9 fish per trip, a rate of catch of 0.47 fish per man-hour. This is about average for the State. However, he took bass at a rate far exceeding that from any body of water in Maryland thus far studied. The estimate of total bass taken from the river is 80,600 fish. This amounts to 475 bass per mile of stream. If they weighed 12 ounces on the average (to be conservative), there was a harvest of 60,000 pounds of bass—30 tons.

The sunfish group, mostly yellowbelly sunfish, accounted for 38 percent of the catch. There were an estimated 99,000 of these fish taken. The catfish, mostly channel catfish, was the third most important group in the catch, about 68,000 being taken.

385. Carter, Ellis R. 1954. AN EVALUATION OF NINE TYPES OF COMMERCIAL FISHING GEAR IN KENTUCKY LAKE. Trans. Ky. Academy of Sci., Vol. 15, No. 3, Oct., pp. 56-80.

During experimental use of nine types of commercial netting equipment, in five representative areas of Kentucky Lake, 36 species of fish were taken, of which 15 were game and pan fishes, 16 were commercial species and 5 were forage and trash fishes. Two additional forage species were taken in population samples made with rotenone. During 5,347 net days, 11,212 fish were taken, weighing 11,575.2 pounds.

Of the nine types of equipment, hoop nets are easiest to use and took predominantly commercial species. Wing nets took more fish, numerically, than any other type, but the catch was 82.07 percent game and pan fishes. Any of the seven barrel-type nets used were more successful when constructed with two throats.

Gill nets were inefficient in mesh sizes over 3 inches, and were selective for game fish in mesh sizes under 3 inches. Trammel nets were slightly more successful in taking commercial species. Wire baskets took the smallest fishes; however, 75.30 percent were game fish. Wood baskets produced the lowest average return per unit of effort, but harvested 79.5 percent commercial fishes.

Heart-lead nets caught a greater total poundage and also more pounds per net day than any other type. Lead nets were the second most successful type. Both, however, were rather selective for game fishes, which comprised 84.94 and 68.8 percent, respectively, of the poundage take of these nets.

The total harvest consisted of 58.75 percent by weight game and pan species, 35.56 percent commercial species, and 5.69 percent forage and trash species. The white crappie accounted for 82.89 percent of the game fish and carp composed 22.67 percent of the commercial group. Carp are not considered overabundant. Nets were baited in an effort to insure a representative catch of this species.

Six population samplings by use of rotenone were conducted in coves adjacent to netted areas. Results of these samplings showed 9.33 percent by weight

game and pan species, foremost of which is the largemouth bass. Commercial types made up 15.89 percent of the sample, drum producing the greatest weight of the commercial species. Forage and trash types made up 74.78 percent of the total weight of the combined rotenone samples, and shad accounted for 95.11 percent of this weight.

Discrepancies between the harvest from nets and that from rotenone can be due to at least three different factors. First, rotenone sampling of necessity was confined to shallow cover areas while nets were used in more open locations. Thus, different habitats were involved. Second, the rotenone killed many of the smaller forage fishes which were not taken in netting operations. Thus, the ratio of game to forage fishes differ markedly when the two methods are compared. A third factor to be considered is the relative selectivity of the two methods for certain species. This is suggested by the gizzard shad, which comprised almost three-fourths of the total poundage harvested by rotenone but only slightly more than one percent of the total poundage from nets.

386. Elser, H. J. and R. D. Van Deusen. 1954. DEEP CREEK LAKE REPORT 1948 THROUGH 1952. Md. Dept. of Res. and Edu. Resource Study Rpt. No. 3, Feb., 19 pp., multilithed.

The work reported here is preliminary in nature and was conducted on a cooperative basis by the Department of Game and Inland Fish, the Department of Research and Education and, on occasion, the University of Maryland and the Property Owners' Association of Deep Creek Lake. The analysis of the data and its reporting were the responsibility of the Department of Research and Education.

Deep Creek Lake, a Maryland water-power reservoir, was first flooded in 1924, but it was not until a year later that the basin was filled to operating level and fishing was permitted.

The investigative work which produced much valuable information has thus far failed to turn up an adequate explanation for the low return to the fisherman. Deep Creek Lake in its brief history has had a series of booms and depressions in its fishing. It is in a depression at the present time, but it appears that it may be on the way to a boom again. The lake is of low productivity but probably not so low as would be indicated by the harvest. The unstable water level undoubtedly contributes to poor spawning. The structure of the population appears to be good, except for forage fishes, in which there seems to be a proper adjustment between predator, pan and bottom fish. The shortage of forage appears to be made up chiefly by yellow perch. Growth of all species except yellow perch is good, the implication of course being that there is enough to eat for all kinds of fish present, except for the last-named species.

An addendum report covering the 1953 fishing season shows that nothing in the data collected in 1953 indicated that any changes should be made in the conclusions or speculations of the report. On the other hand, several hypothesis put forth have been considerably strengthened by the new data.

387. Rawson, D. S. 1955. MORPHOMETRY AS A DOMINANT FACTOR IN THE PRODUCTIVITY OF LARGE LAKES. Proc. of the Int. Assoc. of Theo. and Appl. Limnol., Vol. 12, pp. 164-175.

The early efforts of limnologists to understand the processes of biological production in lakes, led to the primary classification of lakes on a trophic basis. In this classification the edaphic situation, controlling the supply of nutrient materials from the watershed, is regarded as the primary determinant of trophic condition. It was soon recognized that the morphometry or shape of the lake basin, might also determine trophic type. It is obvious also that in some regions climate will provide a third set of factors which will dominate the situation.

It appears that morphometric factors have a dominant effect on biological production in many large lakes across Canada. This conclusion is supported by the demonstration of inverse correlation between mean depth and the standing crops of net plankton, and between mean depth and macroscopic bottom organisms in some 20 large lakes. Mean depth has also been correlated inversely with the long-term fish production of the Great Lakes and other large lakes in western Canada. It is possible that long-sustained fish production may be a better indication of productivity than the standing crops of plankton and bottom fauna. Equations have been derived and curves drawn to represent the theoretical relationship between mean depth and amounts of plankton, bottom fauna and fish production in these lakes. Deviations of the actual amounts of these materials from those expected theoretically appear in most cases to be attributable to the modifying effects of climatic or edaphic conditions.

388. Olive, John R. 1955. SOME ASPECTS OF PLANKTON ASSOCIATIONS IN THE HIGH MOUNTAIN LAKES OF COLORADO. Proc. of the Int. Assoc. of Theo. and Appl. Limnol., Vol. 12, pp. 425-435.

This study was undertaken in an attempt to determine the composition, relative abundance and ecological significance of plankton population in 66 Colorado lakes. All of these lakes lie between the elevations of 10,000 and 12,000 feet above sea level and are located in either sub-alpine or alpine ecological zones.

The 66 lakes were broken into four groups on the basis of their geographical location within the State. The groups were then given the following numerical designations: Group I—Grand Mesa Series; Group II—Rabbit Ears Series; Group III—Miscellaneous; Group IV—Rawah Series. Although these lake groups are widely separated geographically, they are all located within the same general type of up-thrust mountain formation and as a result, the groups could be chosen for their conformity of typology as to basin, size, shape and general physiography. Sampling was accomplished over a period of two and one-half seasons. In most cases, the presence of snow in the mountains determined the time and duration of the field work. Therefore, summer seasons were emphasized as periods of collection. The plankton was taken by two methods: (1) by using the Wisconsin plankton net in conjunction with the Kemmerer-Juday water sampler,

(2) by towing the same net for known horizontal or vertical distances.

There is great similarity between plankton populations of the four lake groups. Organisms that tend to predominate in one group are usually predominant or at least important elements in the population of the other lake groups. The same statement is generally true of the categories of characteristics and incidental plankters. In many respects this is to be expected since plankton shows such great cosmopolitanism. When approached with this view, the study areas in Colorado are in reality quite close together. On the other hand there is certain specificity in the planktonic structure of the high mountain lake habitats. For example, organisms such as Diaptomus shoshone are somewhat confined to lakes above 10,000 feet in Coloardo. They seem to be most adaptable to alpine or subalpine situations. No doubt this factor applies to many of the less conspicuous plankters in the high lakes. Percentage of occurrence is markedly similar in all lake groups when the Protozoa, Rotatoria, and Entomostraca are scrutinized. As a group, the entomostracans were the most predominant organisms and lake group III only slightly departed from this generalization. In fact, when analyses of variance were applied to the occurrence and composition of the plankton, no significant difference was detected. In general the production of the four lake groups was the same.

389. Hicks, Steacy D. 1955. A METHOD FOR RECORDING AND SORTING OCEANOGRAPHIC AND LIMNOLOGICAL DATA. Am. Soc. of Limnol. and Oceanogr., Spec. Publ. No. 23, Feb., 5 pp.

The accumulation of voluminous station data by small oceanographic and limnological laboratories presents the problem of a proper method for the recording, active filing, and sorting of the data. A completely satisfactory method should combine such features as simplicity of operation, minimum expense, and flexibility for future introduction of new sorting requirements for various types of data. A single, complete file, which avoids the necessity of transcribing records, and in addition, can be sorted directly to many parameters, is also desirable. Use of the McBee Keysort punch card system is suggested for recording, active filing, and sorting of oceanographic and limnological data for the following reasons: (1) Sorting for numerous parameters such as position, date, type of station, etc., is accomplished with one central file; (2) errors due to numerous transcriptions to various forms and files are eliminated through the use of a single file; (3) no special equipment is needed; (4) the filing system is not expensive to set up or operate (about 4.79 cents per card); (5) a specially trained person is not needed to operate the filing system; and (6) the system possesses flexibility for expansion in quantity, new types of station data, and new requirements for sorting the data.

390. Rivas, Luis Rene. 1953. THE PINEAL APPARATUS OF TUNAS AND RELATED SCOMBRID FISHES AS A POSSIBLE LIGHT RECEPTOR CONTROLLING PHOTOTACTIC MOVEMENTS. Bull. of Marine Sci. of the Gulf and Caribbean, Vol. 3, No. 3, Dec., pp. 168-180.

A combination of closely related light transmitting structures dorsal to the brain of tunas and other scombrid fishes is described as the "pineal apparatus." Owing to the functional relationship apparently existing between this apparatus and the pineal area of the brain, and on the basis of the known correlation between light exposure of the pineal area and phototaxis in fishes, it is assumed, pending further confirmation, that the pineal apparatus may be a light receptor partially controlling phototactic movements. (A)

391. Rivas, Luis Rene. 1954. A PRELIMINARY REPORT ON THE SPAWNING OF THE WESTERN NORTH ATLANTIC BLUEFIN TUNA (THUNNUS THYNNUS) IN THE STRAITS OF FLORIDA. Bull. of Marine Sci. of the Gulf and Caribbean, Vol. 4, No. 4, Dec. pp. 302-322.

Evidence indicating that the western north Atlantic bluefin tuna spawns in the Straits of Florida during May and early June is presented. Such evidence includes the occurrence of ripe and recently spawned adult fish simultaneously with what may be fertilized eggs and larvae. Further evidence includes the occurrence of juveniles and young in the vicinity of the spawning grounds. It is inferred that the large, adult fish spawning in the Straits of Florida are the same which are found in northern waters during summer. The discovery of spawning grounds in the western Atlantic also suggests that the American and European bluefin tuna represent separate, independent units. (A)

392. Burrows, Roger E. and Harry H. Chenoweth. 1955. EVALUATION OF THREE TYPES OF FISH REARING PONDS. Fish and Wildlife Service Research Report No. 39, 29 pp.

Hydraulic investigations were conducted on three types of fish-rearing ponds: the Foster-Lucas, circular, and raceway. Models constructed on 1/10 scale effectively reproduced the hydraulic conditions found in the prototypes. Flow patterns were observed by means of floats and dyes. The degree of short circuiting, mixing, apparent detention time, and probable flowing-through time were determined by means of dye injection in the water inflow and measurements of the time of appearance and concentration of the dye at the outflow.

Differences between the hydraulic characteristics of the three types of ponds were closely correlated with known differences in their physical and biological characteristics. The four major criteria used to establish pond efficiency were carrying capacity, disease inhibition, food distribution and facility of cleaning.

Of the ponds studied, no one type could be considered superior under all conditions of fish-cultural operations. The Foster-Lucas pond, however, was definitely inferior to either the circular or raceway type.

393. Hooper, A. D. and J. M. Hester. 1955. A STUDY

OF 36 STREAMS THAT WERE POLLUTED BY AGRICULTURAL INSECTICIDES IN 1950. Ala. Dept. of Conservation, Fish. Rpt. No. 2, March, 13 pp.

During 1950, 80 to 95 percent of the total cotton acreage in 5 north Alabama counties was treated with 19,391,940 pounds of cotton insecticides. Because of heavy rains large quantities of the insecticides were washed into the streams. During January, February and March 1953, from 1 to 3 bottom samples were taken from each of the 36 streams studied; fish population studies were conducted in 6 of these streams in August and September 1953. A total of 14 types of bottom organisms were present in the samples. Oligochaeta were found in all of the streams and Chironomidae were present in 26. However, none of the streams appeared to be supporting a great variety of organisms. The fish population studies in the 6 streams sampled indicated that none of them were supporting a desirable population. The general lack of carnivorous species in most of the streams was evident and in 3 of the 6 streams the carnivorous species were not of sufficient size to compute ratios of total poundage of forage species and total poundage of young of forage species compared with total poundage of carnivorous species. In 50 percent of the streams game fish constituted less than 3.5 percent by weight of the total fish population.

394. Cassie, R. M. 1954. SOME USES OF PROBABILITY PAPER IN THE ANALYSIS OF SIZE FREQUENCY DISTRIBUTIONS. Australian Jrnl. of Marine and Freshwater Research, Vol. 5, No. 3, pp. 513-522.

Methods are described by which the component groups may be extracted from polymodal size frequency samples by the use of probability graph paper. Four examples are given illustrating: the solution of a distribution with more than two modes and with only one exposed flank; the coordination of fish age determinations by the two methods, length frequency analysis and scale reading; a bivariate sample where the two means coincide though the standard deviations are different; a method of correcting for truncation. (A)

395. Crowe, Walter R. 1955. THE BLUEGILL POPULATION OF BIG BEAR LAKE, OTSEGO COUNTY MICHIGAN. Papers of the Mich. Acad. of Sci., Arts and Letters, Vol. 40, pp. 111-117.

The almost complete failure of new bluegill year classes to appear during a period of more than a decade is extraordinary. Survival of bluegill progeny from year classes subsequent to 1938 in Big Bear Lake has been negligible. The poor survival is more striking when one considers that this lake appears to be admirably suited to the production of centrarchid fishes.

Big Bear Lake covers 350 acres, has a maximum depth of 35 feet, and a mean depth of 15.8 feet. Since the lake is thermally unstratified, the whole basin is habitable by fish throughout the year. Bottom soils consist of sand and gravel at the margin and of pulpy peat underneath the deeper water. The game-fish population consists of largemouth bass, northern smallmouth bass, pumpkinseeds, northern rock bass, and yellow perch. There are no walleyes or northern pike. Coarse fish are represented by the abundant white sucker and the less numerous northern brown and northern yellow bullheads. Forage species present are the bluntnose minnow, the northern common shiner, the western mudminnow, the western banded killifish, the northern muddler, and the Iowa darter. Except for the perch, all of the game fish make excellent growth. According to anglers, the lake offers good fishing.

The 1938 year class may have represented stocked fish, but this is regarded as improbable in view of numerous studies on survival of hatchery bluegills in other lakes and in view of the poor survival in Big Bear Lake from plantings made in 1937 and 1939. Another possible explanation for the poor survival of bluegills hatched after 1938 is predation. Predation on bluegills by other species in Big Bear Lake has not been carefully investigated; its possible importance as a limiting factor is merely suggested here.

Investigations of the fish population of the lake after 1946 have been brief, carried on at most for a day or two each year. Sufficient collecting has been done to reveal that bluegills are extremely scarce. On the other hand, the species has not disappeared entirely (a single three-year-old was captured by trap net in 1953), and the appearance of a successful year class at any time remains a distinct possibility.

396. Anonymous. 1955. AQUATIC LIFE WATER QUALITY CRITERIA. (First progress report of the Aquatic Life Advisory Committee of the Ohio River Valley Water Sanitation Commission.) Jrnl. of Sewage and Industrial Wastes, Vol. 27, No. 3, March, pp. 321-331.

Early in 1952 an Aquatic Life Advisory Committee was formed to assist the Ohio River Valley Commission in the formation of rational criterial for water quality with reference to the production of fish crops. The functions of this committee are purely advisory and in no way connected with enforcement of specific regulations or determination of proper water use in particular parts of the water system.

The problem of establishing dissolved oxygen requirements has many inter-related facets. Any recommendations for suitable dissolved oxygen levels must take the following considerations into account: (1) The minimal oxygen requirements of the fish. (2) The necessary margin of safety required to allow for activity, increased body temperature, increased carbon dioxide, lowered pH, and the presence of toxic substances. (3) The fact that a fish may tolerate a low oxygen concentration for a few hours, but will not thrive if this level is maintained indefinitely. (4) A well-rounded fish population does not occur in areas where the oxygen content falls below 3 p.p.m. and a coarse fish population does not occur when the oxygen concentration falls below 2 p.p.m. (5) The quantity of dissolved oxygen in natural waters may fluctuate over a wide range. (6) A fall in the oxygen concentration to an anoxial level, even for a short time, or infrequently, may destroy the fishing potential of a stream, if not the entire fish population. (7) The recommendation of an

average value for dissolved oxygen would not set the critical lower limit on the permissible oxygen level.

The Committee made the following recommendations:

(A) Dissolved Oxygen. The dissolved oxygen content of warm-water fish habitats shall not be less than 5 p.p.m. during at least 16 hours of any 24-hour period. It may be less than 5 p.p.m. for a period not to exceed 8 hours within any 24-hour period, but at no time shall the oxygen content be less than 3 p.p.m. To sustain a coarse fish population the dissolved oxygen concentration may be less than 5 p.p.m. for a period of not more than 8 hours out of any 24-hour period, but at no time shall the concentration be below 2 p.p.m.

(B) pH Levels. (1). That pH be recognized as a poor criterion for the expression of toxicity of acids and alkalies in general, and that its use be restricted to the control of the addition of highly dissociated inorganic acids and alkalies known to be non-toxic within the pH range of 5 to 9. (2) That at no time shall acid be added in quantities sufficient to lower the pH below 5, nor alkalies sufficient to raise the pH values above 9; and that, insofar as possible, pH values be maintained between 6.5 and 8.5 to maintain the productivity of the water for aquatic life.

(C) Disposal of Toxic Wastes. (1) The toxicity of wastes to aquatic life in the receiving water can most effectively and reliably be determined by means of bioassays. (2) The bioassay methods for the evaluation of acute toxicity of industrial wastes to fish described and recommended by the Committee on Research, Sub-committee on Toxicity, Section III, Federation of Sewage and Industrial Wastes Associations are endorsed. (3) The final concentration of any waste in the receiving water should be no greater than the 48-hour TL_m X 0.1, that is, the 48-hour TL_m as determined by the bioassay methods recommended multiplied by 0.1, the tentative application factor (TL_m is the concentration of a substance or waste which kills one-half the animals in a specified period of time). Other application factors may be used in specific cases, but only after thorough investigations justifying their use have been made.

397. Morgan, George D. 1954. THE LIFE HISTORY OF THE WHITE CRAPPIE (POMOXIS ANNULARIS) OF BUCKEYE LAKE, OHIO. Jrnl. of the Scientific Laboratories, Denison Univ., Vol. 43, Arts. 6, 7, 8, April, pp. 113-144.

This paper is the result of a study of the white crappies of Buckeye Lake, Ohio, during the years 1950, 1951, and 1952, and from information gathered from test net reports, creel census reports, and from the personnel of the Fish Management Section of the Division of Wildlife, Ohio. White crappies are one of the most abundant of the sunfish family and are common all over the state in large reservoirs, lakes, and streams. They are easy to propagate and thrive in fairly warm water in shallow lakes and reservoirs. The most active feeding periods of this fish in Ohio waters are April, May, and June, and during September and October. The most inactive months are July and August when the water temperatures range between 70° and 87° Fahrenheit.

Buckeye Lake white crappies do not mature until they are two years old and some do not mature until they are three years old. The smallest ripe female observed in Buckeye Lake was 5 7/8 inches in length. They begin to spawn during late April and continue to spawn through May, June, and even into July. The height of the spawning period is May and early June. The nesting site is quite variable. They may nest in depths ranging from 2 inches to several feet, and according to one observer to a depth of 20 feet. The nests may be made on mud, sand, clay, gravel, or in vegetation. The number of eggs produced varies from 1908 in fishes 5 7/8 inches in length to 325,677 in fishes 13 inches in length. The incubation period varies between 24 and 27 1/2 hours at temperatures of 70° to 74° Fahrenheit. The length of the larvae at hatching varies from 1.215 mm. to 1.98 mm. as compared with 2.79 for the bluegill. At 14 days the larvae measured 6 millimeters. The annulus may be formed over a period of several months, from March to September. Young fishes appear to form annuli early in the summer while older fishes form annuli later in the summer. The yearly increment for the first year is greater than in other succeeding years. Following the first year's growth there is a gradual decrease in the yearly increment during each ensuing year with the exception of the fourth and seventh years. The average yearly growth of both male and female is about the same. However, during the sixth and seventh years the females grow faster than the males. The plumpness, or K value, of Buckeye Lake white crappies is less than the white crappies of Lake Decatur, Ill., with the exception of fishes 10 and 11 inches in length. As a rule the K values are greater in large fishes than in small fishes. There is a definite relationship between the K values and the ratios of body weight to ovary weight. During the spawning period when the ratios of body weight to ovary weight are low the K values are high. The predominant food of the white crappie is the gizzard shad, followed by midge pupae and Cladocera. During March, Copepods and Cladocera made up 100 percent of the food in the stomachs. The food during May consisted of Cladocera, midge pupae, and shad respectively. During June and July the number of each decreased. In August 89 percent of the food eaten consisted of Cladocera.

398. Davis, Charles C. 1955. PLANKTON AND INDUSTRIAL POLLUTION IN CLEVELAND HARBOR. (Part IV of "A Preliminary Study of Industrial Pollution in the Cleveland Harbor Area, Ohio.") Jrnl. of Sewage and Industrial Wastes, Vol. 27, No. 7, July, pp. 835-850.

Between September 1950 and September 1951 a study was made of the Cleveland Harbor area in connection with a survey of pollution conditions in Lake Erie. Based on this study, previous reports have

been published on the chemical and physical results (17) (20), on the analyses of the phytoplankton (18), and on the analyses of the zooplankton and the seasonal ecology of the entire plankton (19).

Two inter-connected aspects of the study of the plankton in relation to pollution are: (a) the effect of pollutants on the plankton, and (b) the use of the plankton organisms as indicators of polluted waters. These two aspects stand to each other as the two sides of a coin.

Nine stations in the Cleveland Harbor area of Lake Erie were visited every two weeks during the year September 1950 through September 1951. Quantitative plankton samples were obtained from the surface and from the 6.5-m. depth at each station. In the Cleveland Harbor area, the major portion of the industrial effluents, and an important volume of the domestic effluents, enter Lake Erie through the Cuyahoga River.

The quantity of the plankton was uniformly small at those stations where the pollution (as indicated by the Fe content) was greatest, but apparently this was associated with the lower productivity of the river, rather than directly with the pollution. Small plankton quantities were also encountered in unpolluted water. Therefore, it is thought that the standing crop of the plankton is not a reliable index of pollution in localities such as that under investigation.

Some common plankton species were lacking, or were rare, in the most highly polluted water. Other forms (mostly tychopelagic) that were common at polluted stations were rare or lacking elsewhere. Again, however, it is probable that these phenomena were the result of river conditions and not the result of pollution. Therefore, in locations such as the Cleveland Harbor area, the presence or absence of particular plankton species is not a reliable index of pollution.

Examples are given of species of phytoplankton and zooplankton which occurred more frequently in a dead or moribund condition at the more highly polluted stations than elsewhere. These are considered to be indicators of pollution. However, other means are more sensitive detectors, and more easily applied. That the harmful effects of effluents is important is shown by the death of plankters, and it is proposed to investigate these effects more closely.

399. Pelgen, David E. and George W. McCammon. 1955. SECOND PROGRESS REPORT ON THE TAGGING OF WHITE CATFISH (ICTALURUS CATUS) IN THE SACRAMENTO-SAN JOAQUIN DELTA. Calif. Fish and Game, Vol. 41, No. 4, pp. 261-269.

Tagging studies of the white catfish (Ictalurus catus) in the Sacramento-San Joaquin Delta area of California were begun in 1952 in order to (1) develop a satisfactory tag for catfish, (2) estimate annual rate of harvest, and (3) obtain data on the movements of white catfish. In the winter of 1952-53, 1,499 tagged white catfish were released at three localities. Disk-dangler tags and staple tags constructed of cellulose nitrate disks and tantalum wire were used. Returns from sport and commercial fishermen totaled 15.1 percent during the first year. A significant difference existed between size of fish tagged and size of fish from which tags were returned. Fewer tags were returned from fish under 8.5 inches fork length than would be expected theoretically. There was no significant difference between returns from disk-dangler tags and staple tags. A correction was made to compensate for nonreturn of all tags by commercial fishermen. The revised figure indicated a minimum harvest of 17.2 percent in 1953. This estimate is tentative, pending the results of further studies. Movement of the fish from the point at which they were released was sporadic, and without apparent direction. No evidence of a definite migration was detected. (A)

400. Sedgwick, Drummond. 1955. WINTER SALMON. The Salmon and Trout Mag., No. 143, Jan., pp. 31-33.

Atlantic salmon that run in rivers which are ice free in winter may enter fresh water from the sea on spawning migration during any month of the year. Salmon are usually roughly grouped by the pattern of their scale growth, irrespective of their time of entry. Those which show no summer growth on the scales, following the peripheral winter zone, being described as spring salmon, and those which have growth being summer salmon. Typical spring salmon have very little development of the gonads, while summer slamon show proportionately greater development as the season advances. Gonad development usually occurs in conjunction with the development of secondary sex characteristics, such as colour changes and kype formation.

A group of gravid salmon may enter rivers on spawning migration during what is normally the close season. In the rivers of the South-West of England an effort is being made to elucidate the behaviour of these fish. The salmon enters during the late autumn and winter. The latest entering fish in the group do not come into fresh water until after Christmas, and have been observed spawning as late as the third week in March. As these salmon differ in many respects from the spring or summer group, they are, perhaps, best described separately as winter salmon.

The characteristics of winter salmon in West Country rivers which have so far been noted, are as follows: Their ova development is well advanced or they are fully gravid; females are bright silver in colour and in excellent condition. In both males and females the flesh is red and of fine consistency, with a high fat content. The males have very much less development of the secondary sex characteristics than is found on late entering summer salmon, which may come into a river at the same time as the first of the true winter salmon. The scale development is peculiar to the group but is very similar to that found on spring salmon. The winter salmon spawn mainly in the lower reaches of the river in which they run. Some of the group have been observed spawning in the head of the tideway where the fresh water is backed up on spring tides. Winter salmon most probably spawn almost entirely with others of their own group, as by the time winter salmon enter

a river, the spring and summer fish have normally completed their spawning operations. The condition of winter salmon from a commercial aspect as food, appears, from sampling, to be very good and better than summer salmon which enter fresh water after the end of June.,

The main age groups into which winter salmon fall are large grilse type, which if not sexually developed would be small spring salmon. The "small" winter salmon, which, if not developed would be large spring salmon.

401. Macan, T. T. 1955. A KEY TO THE NYMPHS OF BRITISH EPHEMEROPTERA. The Salmon and Trout Mag., No. 143, Jan., pp. 59-70.

This key is written for the naturalist who does not possess a microscope and has only a hand-lens or small magnifying glass to aid his vision. It is also assumed that users of the key will be interested in the living nymph, which often has some characteristic feature, for example the way the tails of Cloeon curl down at the tip, lost at death. Nearly all the illustrations have been drawn specially from living specimens with the aid of no more than a hand-lens.

The problem of names immediately faces the author of such a work. Many Ephemeroptera have fishermen's names, but these refer only to particular stages and do not coincide with the species name of the naturalist. For example, Baetis pumilus and Baetis niger live in quite different kinds of places and the nymphs can easily be distinguished by the naked eye. The adults are less distinct and fishermen refer to them both as Iron Blue Duns when they are in the dun stage. When they change skins, males of both species become Jenny Spinners, females Little Claret Spinners (Harris 1952, "An Angler's Entomology", New Naturalist, No. 23, pp. 136, 137). Obviously none of those names can be applied to the nymphs, and accordingly only the Latin names have been used in this key.

402. Greeley, John R. 1955. SURVIVALS OF PLANTED ATLANTIC SALMON IN LAKE GEORGE. New York Fish and Game Journal, Vol. 2, No. 1, January, pp. 1-12.

As part of a study of methods for increasing salmon in New York lakes, experimental plantings of Atlantic salmon were made. Yearlings, planted in streams tributary to Lake George, included 3,000 marked individuals in 1948 and 6,000 in 1950. In order to check relative survivals with reference to each planting stream, three different fins (adipose, right ventral, and left ventral) were clipped from lots of fish planted in three different streams each year. Upon sampling, age determination by the scale method was used to prevent confusion in interpretation of clip marks. Survival was evaluated on the basis of 131 individuals netted during the spawning season of 1952. Salmon released after handling were tagged, thus preventing errors in counting at recapture. Analysis of recoveries of marked salmon according to planting stream indicated some recoveries from each of the six streams. Although Lake George was known to have had a small population of landlocked salmon prior to the planting experiments, analysis of ratios of marked to unmarked salmon recovered indicated that planted Atlantic salmon accounted for virtually the entire population. Also, clip marks were recognizable at recapture without major sources of error. These fish are of high angling value and are indistinguishable from landlocked salmon. They yield eggs of excellent quality for fish cultural purposes. (A)

403. Burdick, G. E., Howard J. Dean and Earl J. Harris. 1955. TOXICITY OF EMULSIFIABLE ROTENONE TO VARIOUS SPECIES OF FISH. New York Fish and Game Journal, Vol. 2, No. 1, January, pp. 36-67.

The toxicity of rotenone to six species of fish was studied under controlled laboratory conditions. Toxicity curves were constructed for comparing the effect of temperature, acid and alkaline waters, and variation between species. The data are restricted to 100 percent mortality occurring within an exposure period of not more than 24 hours.

An additional variable was found to be associated with the size of the fish and correction was made by multiple regression whenever the effect was found to be significant by the use of the t-test.

Generally, decrease in temperature and increase in length were found to extend the time for death. No difference in effect was found between the two waters used. A wide variation was found among the six species tested in the exposure required for death a at equivalent concentrations.

There was found to be no significant difference in the toxicity of rotenone in a faintly acid, low-alkalinity water, when compared to a water which was slightly alkaline with a much higher methyl orange alkalinity. Increased temperature increases the toxicity of rotenone. The slope for the regression of time on temperature is a curve which approximates a straight line for brown trout at concentrations from 0.05 to 0.40 p.p.m. for temperatures between 60° and 70° F., but which increases in curvature rapidly between 55° and 60° F. Toxicity curves indicate that the species studied fall in the following order of increasing resistance to rotenone: brown trout, rock bass, creek chub, smallmouth bass, common sucker, and brown bullhead. The separation of these curves in time is sufficient to indicate that a dosage of 0.50 p.p.m. is inadequate if a complete kill is required on a fish population which includes suckers or bullheads.

While the effect of size, calculated in terms of length, was generally significant in the evaluation of the time for death, the data were inadequate for the determination of the curvature, or lack of curvature, in the slope. At low levels of concentration it was found that affected fish recovered permanently when removed to clean water, even though removal was delayed up to 18 hours. In the case of some of the higher concentrations, no recovery was possible in spite of almost immediate removal. Variation of the oxygen content between 8.8 and 11.4 p.p.m. seemed to have no significant effect on the toxicity of rotenone solutions measured in terms of time of death.

404. Suttkus, Royal D. 1955. AGE AND GROWTH OF A SMALL-STREAM POPULATION OF "STUNTED" SMALLMOUTH BLACK BASS, MICROPTERUS DOLOMIEU DOLOMIEU (LACEPEDE). New York Fish and Game Journal, Vol. 2, No. 1, January, pp. 83-94.

A study of smallmouth bass of Fall Creek, Tompkins County, New York, between the village of McLean and Beebe Lake was carried on during 1948 and 1949. A total of 966 specimens obtained by various methods was used for the study. The bass of Fall Creek were determined to be stunted although they were relatively plump (K=2.35). It was found that annuli were formed during the latter part of May and early June. The maximum annual increase in length occurred during the first year. The length-frequency distribution of the calculated fork lengths exhibited a large overlap in most age groups. A statistical test made on a sample of 213 specimens showed no significant difference in the growth rates between the sexes. (A)

405. Haskell, David C. and William J. Adelman, Jr. 1955. EFFECTS OF RAPID DIRECT CURRENT PULSATIONS ON FISH. New York Fish and Game Journal, Vol. 2, No. 1, January, pp. 95-105.

Comparing the effects of rapidly pulsating direct current, slowly pulsating direct current, and steady direct current in producing motion of fish toward the anode in a shocker circuit, it was found that about 20 percent lower voltage is required by a current of 180 pulsations per second than by steady current. The threshold voltage was lowest when the long axis of the fish coincided with a line connecting the electrodes and highest when the fish was at 90 degrees to this position. The resulting motion was a minimum for the aligned position and a maximum for the 90-degree position. Rapidly pulsating current produced more erratic motion and had less power to hold fish at the anode than slowly pulsating current. It is pointed out that the electrical power required by rapidly pulsating current may be only about a tenth of that required by steady current. (A)

406. Webster, Dwight A., John L. Forney, Robert H. Gibbs, Jr., Jack H. Severns and William F. Van Woert. 1955. A COMPARISON OF ALTERNATING AND DIRECT ELECTRIC CURRENTS IN FISHERY WORK. New York Fish and Game Journal, Vol. 2, No. 1, January, pp. 106-113.

Alternating and direct current electric generators of equal rating (2,500 watts, 230 volts) were tested for maximum recovery of 640 marked brown trout in a 600-foot section of Cascadilla Creek, Ithaca, New York. In addition to type of electric current the experiment was designed to measure the effect of variations in fish size, water temperature, and stream type (pools and riffles). A recovery of about 80 percent of the marked trout was realized with alternating current and one of about 40 percent with direct current. Both temperature and fish size showed significant effects as judged by analysis of variance. Other considerations are involved in a choice of current for fish shocking, but it is evident that for quantitative work alternating current has a definite place where maximum recovery of fish is an important factor. (A)

407. Petty, A. C. 1955. AN ALTERNATE-POLARITY ELECTRODE. New York Fish and Game Journal, Vol. 2, No. 1, January, pp. 114-119.

An alternate-polarity electrode with alternating current furnished by a 230-volt gasoline-driven generator has been developed for shocking fish in streams. This electrode was devised as a result of experimentation aimed at developing a more efficient and more effective movable electrode for fish collection work. The alternate-polarity electrode described consists of sections of braided shielding cable mounted on connected wooden dowels manipulated by means of a wooden handle at each end of the chain of dowels. Insulated wires which carry the current from the generator are connected to the braided shielding cable sections in such a manner that adjacent sections are of opposite polarity which produces an electric field in the water surrounding the electrode. Results obtained during the past three years with this particular type of electrode have been very satisfactory. Further experimentation with other types of electrodes based on the alternate-polarity system should produce an even more efficient apparatus. (A)

408. Haskell, David C., Donald Geduldig and Edward Snoek. 1955. AN ELECTRIC TRAWL. N.Y. Fish and Game Jrnl., Vol. 2, No. 1, Jan., pp. 120-125.

Various problems encountered in attempting to develop an electric trawl for deep water are discussed. A method involving two pairs of electrodes operated by portable alternating current generators proved successful in collecting warm-water species. (A)

409. Greeley, John R. 1955. THE EFFECT OF SIZE AT PLANTING ON SURVIVAL AND TIME OF DOWNSTREAM MIGRATION OF ATLANTIC SALMON IN A TRIBUTARY OF LAKE GEORGE. New York Fish and Game Journal, Vol. 2, No. 2, July, pp. 161-172.

Annual planting of yearling Atlantic salmon in tributaries of Lake George during April and May since 1948 has materially increased the angling resource of "landlocked salmon". "Immediate" migration from stream to lake (during year of planting) is desirable because (1) the rapid period of lake growth commences sooner and (2) heavier densities of salmon can be supported temporarily in a stream during the spring period of high flow. "Delayed" migration (during year after planting) affords a useful means for utilizing the permanent carrying capacities of streams. Experiments to test the effect of size at planting on the time of downstream migration were carried on in 1953 and 1954 in Huddle Brook, a tributary of Lake George.

A trap weir was constructed early in May 1953, and small salmon yearlings, averaging 3.5 inches in length, were planted. Since salmon of this same average size had been planted in 1952, the first season of trapping in 1953 afforded a basis for comparing "immediate" and "delayed" migration. Trapping was discontinued December 22 and resumed March 31,

1954. On April 22 a plant of larger salmon, averaging 5.5 inches in length, was made using adipose fin-clip marks to distinguish them from overwintering fish. Trapping was terminated June 20.

Data resulting from the total of 830 salmon trapped during the two years indicated downstream migration to be confined to April, May, and June (an October catch of two parr being considered a purely local movement). Some degree of transformation from the parr to the smolt stage was clearly demonstrated as a factor, but there was a wide variation in the degree of this development. The planting of 5.5-inch yearlings (all in or near the smolt stage at planting in 1954) gave 27.1 percent "immediate" migration, while the planting of 3.5-inch yearlings (approximately 95 percent in the parr stage at planting in 1953) gave only 0.6 percent "immediate" migration. The two plantings of 3.5-inch yearlings gave closely comparable figures for "delayed" migration, the 1953 trapping of the 1952 plant (only partially complete due to some migration before initial operation of trap) giving a return of 3.9 percent and the 1954 trapping of the 1953 plant giving a return of 3.1 percent.

The study suggests the desirability of stocking Lake George tributaries with small yearling salmon up to their estimated capacity to carry and grow such fish until the following spring and of adding to such number sufficient large yearlings to utilize temporarily increased carrying capacities during the spring months and to migrate before the onset of summer low-water conditions. Proper adjustment of sizes and numbers to conditions of individual streams would give a "self-thinning" plant. (A)

410. Smith, Ralph H. 1955. EXPERIMENTAL CONTROL OF WATER CHESTNUT (TRAPA NATANS) IN NEW YORK STATE. New York Fish and Game Journal, Vol. 2, No. 2, July, pp. 173-193.

In about 70 years the introduced water chestnut or caltrop has become a noxious water weed over more than 2,500 acres of fresh water in the Mohawk-Hudson-Barge Canal waterway. More recently it has spread to Lakes Keuka and Champlain. Attempts to control water chestnut by underwater mowing failed for lack of complete coverage each season. Spraying with dangerously volatile formulations of 2,4-D had to be halted because of claims of crop damage.

Various types of herbicides, mostly nonvolatile, were tested by applications from pack sprayers and boat-mounted power sprayers. Contact type herbicides, such as ammonium sulfamate and pentachlorophenol, were ineffective. Tests showed that an application of amine salts of 2,4-D at a rate of 8 pounds acid equivalent per acre in 50 gallons of total solution per acre, with either fuel oil or water as a diluent, would cause a satisfactory kill of water chestnut. Isolated infestations were reduced from dense mats to as few as one plant per year in a period of 3 to 4 years, when seed suppression was complete each season. Application of herbicide by means of helicopters, to get complete coverage of all water chestnut areas each year, is considered a promising approach to the problem. (A)

411. Lipschuetz, M. and A. L. Cooper. 1955. COMPARATIVE TOXICITIES OF POTASSIUM CYANIDE AND POTASSIUM CUPROCYANIDE TO THE WESTERN BLACK-NOSED DACE (RHINICHTHYS ATRATULUS MELEAGRIS). New York Fish and Game Journal, Vol. 2, No. 2, July, pp. 194-204.

The toxicities of potassium cyanide and of potassium cuprocyanide having cyanide-to-copper mol-ratios of 4.0, 3.75, and 3.0, were measured by a flow-through procedure. The toxicity decreased as the ratio of copper to cyanide increased. The 24-hour median tolerance limits for KCN and for the 4.0, 3.75, and 3.0 mol-ratios were 0.22, 0.38, 0.47, and 0.71 p.p.m. CN, respectively; the 4-hour median tolerance limits were 0.26, 0.53, 0.69, and 1.10 p.p.m., respectively. These values were for one species of minnow, the western black-nosed dace, and for the given conditions of temperature, pH, and dissolved oxygen. In spite of the decrease in toxicity due to the presence of copper, cuprocyanide solutions are sufficiently potent to constitute a pollutional hazard when present in industrial wastes. (A)

412. Loeb, Howard A. 1955. AN ELECTRICAL SURFACE DEVICE FOR CARP CONTROL AND FISH COLLECTION IN LAKES. New York Fish and Game Journal, Vol. 2, No. 2, July, pp. 220-231.

An electrical surface device was constructed and tested to determine the relative effectiveness of moving electrode devices in capturing various species of fish, especially carp. It consisted of four electrodes suspended from the corners of a scow and powered by a 230 volt alternating current generator. Experiments under different conditions in a variety of types of habitat are described and the characteristics of the electric fields created are presented.

The surface device proved to be effective for collecting fish on a small scale, especially in weedy and stumpy areas. Observations indicated that larger fish are more easily shocked than smaller ones, but are more capable of evading the electric fields. Electrical devices of this type are inefficient as means of controlling fish populations by capture. (A)

413. Nichols, Hudson M. 1955. 8740 FISHERMEN REPORT ON REELFOOT LAKE. Tenn. Conservationist, Vol. 21, No. 5, May, pp. 16-17.

During 1954, from March through November, 8740 fishermen (approximately one out of every 6 who fished Reelfoot) were met by creel census clerks as they docked at one of the 22 docks around the lake.

Sport fishermen caught 80 tons of fish last year at Reelfoot. White crappie, bluegill and largemouth bass accounted for 75 of these 80 tons. The remaining 5 tons were mainly channel catfish, yellow bass, drum and sunfish. In fact, game fish made up 96 percent of the total catch.

Fishermen caught more pounds of white crappie than any other fish; 79,000 pounds were harvested. Next in line was the bluegill (45,000 pounds), followed by the largemouth bass (26,000 pounds).

The average Reelfoot bass taken last year weighed almost 1.9 pounds. The average crappie tipped the scales at .6 of a pound, and the bluegill averaged .4 of a pound or just slightly under one-half pound.

The average number of crappie caught for each hour spent fishing for them was one and one-half. In between these two was the bluegill. Bluegill fishing produced just slightly over one fish per hour. This is an extremely low average for the bluegill, but 1954 was a very poor bluegill year.

414. Anonymous. 1955. FISHERMENS' LUCK. (Last Year's Creel Report Summary). Wyo. Wildlife, Vol. 19, No. 3, March, pp. 20-21.

Most of the creel records were obtained by deputy game wardens whose assistance was invaluable. Granted, these estimates have limitations. First, the sample is small—probably less than one fisherman in a hundred was contacted. Second, some individual waters are emphasized more than others. For these reasons strict year to year comparisons cannot be made. However, the statewide creel census is believed adequate for determining trends in fishing success, species and sizes caught through the years. It will become more and more valuable as the number of creels checked is increased and a method devised for giving proper emphasis to data from individual waters. The average success of one and one-half trout per hour for trout waters is essentially the same as shown by the statewide creel censuses for the previous two years. Just one trout per hour is considered excellent fishing. The average catch of 0.3 trout per hour was low from "mixed waters", such as Boysen Reservoir and Lake DeSmet where both trout and warm water fish were important in the catch. However, rainbow trout from these waters averaged 15.4 inches long compared to 10.9 inches from other waters. Ocean Lake and Festo Lake (Platte County) are examples of non-trout waters.

The winter whitefish season on Snake River provided some of the best success of the season—four and one-third fish per hour.

In spite of a drought year and increasing fishing pressure, Wyoming fishing maintained its high quality. The average size of game fish in angler's creels is burbot, 23.9 inches; lake trout, 16.5; grayling, 12.0; rainbow trout, 11.8; mountain whitefish, 11.0; brown trout, 10.6; largemouth bass, 10.6; cutthroat trout, 9.2; golden trout, 8.9; black crappie, 8.9; black bullhead, 8.4; bluegill, green and pumpkinseed sunfish, 8.3; eastern brook trout, 7.8; and yellow perch, 7.8 inches.

415. Swei-yen Koo, Ted. 1955. BIOLOGY OF THE RED SALMON, ONCORHYNCHUS NERKA (WALBAUM) OF BRISTOL BAY, ALASKA, AS REVEALED BY A STUDY OF THEIR SCALES. Dissertation Abstracts, Univ. Microfilms, Ann Arbor, Mich., Vol. 15, No. 9, p. 1681.

This work deals mainly with the scale studies of the red salmon, Oncorhynchus nerka (Walbaum), of Bristol Bay, Alaska. The salt-water growth in the adult scales was studied first. A graphical method was devised in which all scale axes were equated to 100 percent and the average width of circuli in each 5-percent interval was calculated. These averages were then plotted, showing the minimal values which represented the annuli. For any particular size group, a number of scales were summed by each successive interval to secure mean values for each 5-percent interval. Such mean scale graphs were obtained for the scales of the various size classes it was desired to compare as to age. It was shown that two different age groups were responsible for the two major size groups of fish that are characteristic for the Bristol Bay red salmon. The smaller possessed two annuli in the salt-water growth, the larger, three. This was true for both sexes of fish, for all the districts in Bristol Bay, and in all years studied.

By this method, personal interpretation of scale marks was avoided and doubts as to the age significance of the marks determined were removed. It was possible to use size as a criterion of number of years of sea life in the spawning fish, whose scales were eroded at the margin. Since the parts of the scales of fresh-water origin are legible, there was thus furnished a basis for accurate age analysis of the escapement, hence of the total run. This was basic to any scientific study.

The fresh-water growth of the scales was studied in two parts.

First, the growth pattern and age significance of young-fish scales during their fresh-water life were studied by the same method. Samples of young red salmon collected in 1949 from the Wood River system were grouped by semi-monthly periods. Two age classes of fingerlings were present as 2nd- and 3rd-year fish, the former largely predominating. The increase in size as the season advanced was accompanied by addition of growth to the edge of the scales. Circuli at the edge were narrowest in early June and widest in early August. Only one narrow band of circuli, i.e., the annulus, was formed within the year, and this occurred between October and June.

Second, the nuclear area of adult scales from spawning grounds in the Wood River system was studied. Scales from the adults returning in 1951 with two ocean annuli and those in 1952 with three ocean annuli were included, for comparison with the 1949 smolts, since they all originated from the same spawning. Since scale curves for the successive years were similar in each district and since distinctive curves were found for different districts, it is evident that the spawners had returned each to the district in which it had been born. When the scale curves for the nuclear areas of these adult scales were compared with those for the entire scales of the 1949 smolts, intermediary growth between fresh-water and salt-water growth did not appear in such amount as to confuse age determination.

A synopsis of the scale characteristics of the five species of Pacific salmon of both young and adult stages and a key to the identification of adults by means of scale examination is presented. (A)

416. Salo, Ernest Olavi. 1955. SILVER SALMON, ONCORHYNCHUS KISUTCH, SURVIVAL STUDIES AT MINTER CREEK, WASHINGTON. Dissertation Abstracts, Univ. Microfilms, Ann Arbor, Mich., Vol. 15, No. 9, p. 1682.

The objective of the thesis is to present the basic

upstream and downstream migration data and survival rates of artificially and naturally propagated silver salmon, Oncorhynchus kisutch, at Minter Creek, Washington. The studies were conducted at the Minter Creek Biological Station which was established in 1937 by the State of Washington Department of Fisheries. A permanent weir with screening and trapping devices was designed and installed to enable the enumeration of both upstream adult migrants and downstream fry migrants. The different experimental lots of fish were identified by the removal of particular fins.

The numbers of upstream migrants from 1937 to 1954 are listed. The natural run of adults in the stream varies between 2,000 and 2,500 fish. The principal downstream migration of seaward-migrant yearlings is in the month of May and the majority of the migrants are one year of age. The numbers of fish involved in the annual migrations are discussed for the years 1938 to 1954.

Fish reared in the hatchery to the age of three months, showed fresh-water survival rates of less than 11 percent and salt-water survival rates from 4 percent to 10 percent. Additional rearing to six months of age increased the fresh-water survival to 21 percent; however, the marine survival rate was only 3.0 percent. Fish reared for 8 and 9 months had an average fresh-water survival of 40 percent, while plantings of yearlings showed a fresh-water survival of 70 percent; however, the salt-water return of these latter groups ranged from 0.07 percent to 2.88 percent. Thus, an inverse correlation between fresh-water and salt-water survival rates was obtained.

A total survival of 0.70 percent (hatchery mortality included) can be expected for marked Minter Creek hatchery fish which are reared for 11 to 12 months.

Thus, each female spawned artificially would result in a return to the stream of 18 adults, in addition to a contribution of 52 fish to the fishery.

Counts of naturally spawned yearlings revealed apparent limits to the rearing capacity of the stream. Escapements of 1,000 females produced from 18 to 37 yearlings per female (fresh-water survival from 0.70 to 1.42 percent). An increase in the number of yearlings produced per female was evident in the 500-female and 100-female escapements with the production rising to approximately 65 yearlings and 185 yearlings per female, respectively.

The marine survival rates for naturally spawned fish could be accurately determined for five separate years. The marine survival rates were inversely correlated with fresh-water survival rates and former rates varied from about 1.7 percent to 6 percent.

Comparison of returns of adult fish produced by natural propagation with those produced by artificial propagation, for relatively small numbers of spawners, indicates that artificial propagation is more efficient provided long-term (6 to 12 months) rearing is practiced. When 800 females are placed above the weir for natural spawning, 1400 to 1800 adults may be expected to return. In contrast, if 800 females spawned artificially and the yearlings produced are released into Minter Creek, approximately 5,000 adults may be expected. (A)

417. Williams, John Edward. 1955. DETERMINATION OF AGE FROM THE SCALES OF NORTHERN PIKE (ESOX LUCIUS L.). Dissertation Abstracts, Univ. Microfilms, Ann Arbor, Mich., Vol. 15, No. 9, p. 1684.

The ability to determine the age of fish is a necessary tool for the accumulation of scientific facts which will contribute to more intelligent management of this renewable resource. The northern pike, an important game and food fish (as well as a valuable predator), has been considered very difficult to assess as to age from its scales in Michigan. This study set out to determine if and how pike scales could lend themselves to age determination.

Scales were examined for growth characteristics during known intervals from individuals of partly known age (tagged fish which were recaptured after a known interval and increase in size) and those of known age. During the investigation 644 wild fish were tagged in Sugarloaf Lake, Washtenaw County and in Orchard and Ocqueoc lakes, Presque Isle County, of which 142 (22 percent) were recaptured after an average of 170 (range, 1-619) days. Fish were tagged either with a monelmetal strap on the opercle or lower jaw or with a plastic streamer attached to the back with a nylon thread.

The annuli of pike scales were found to differ strikingly according to age. The first annulus was most often characterized by a zone (chainlike in appearance) of extremely irregular, discontinuous circuli. This peculiar formation, which often formed before spawning, was possibly associated with regeneration of the scale margin. The typical second annulus was composed of two or three irregular circuli forming a break in the scale pattern. Later annuli were of several types, most common of which were those indicated by a hyaline mark or by irregular circuli. Nearly all annuli were prominent at the posterior field as a hyaline band, devoid of circuli.

Pike of age-groups I and II often formed their annuli before spawning but older fish usually evidenced it a month or more later. Annuli were laid down between early March and June 1 in the southernmost part of the state and between late March and late June in more northern locations.

Two- and three-year-old pike completed approximately 50 percent of their yearly scale growth by July 1, 75 percent by August 1 and nearly 100 percent by October. The fish apparently grew proportionately more in body length than in scale length over winter.

Occasionally an abrupt increase in growth rate early in the first year, probably associated with a change from insect to fish diet, caused an annulus-like pattern on the scales. A common and often prominent false annulus, which has apparently been responsible for much of the difficulty encountered in aging pike, was indicated as a hyaline mark on the scales of many yearling or older known-age and wild individuals. This check, formed in July and August, is believed to be caused by growth cessation due to reduced feeding during periods of above-optimum water temperatures. Because fall growth, after the

false annulus, is mostly deposited at the anterior portion of the scale, there usually are more than twice as many circuli anterolaterally as posterolaterally outside the false check; growth after a true annulus is more nearly equal in the two fields. The tendency, therefore, is for the summer check to approach or combine with the following true annulus toward the posterior region.

Tags located on the mandible reduced the growth rate by more than 50 percent and reduced the condition so drastically that many individuals so involved did not form annuli. All pike, except those adversely affected by jaw tags, formed a recognizable year mark each year, proving the validity of the annulus for age determination. (A)

418. Nelson, Philip R. and W. T. Edmondson. 1955. LIMNOLOGICAL EFFECTS OF FERTILIZING BARE LAKE, ALASKA. U. S. Fish and Wildlife Service, Fishery Bulletin 102, Vol. 56, pp. 415-436.

Bare Lake, a 120-acre unstratified lake on Kodiak Island, Alaska, was fertilized in 4 successive years with commercial inorganic phosphorus and nitrogen fertilizers. The quantity of fertilizer was in part decided on the basis of prognostic experiments in which jugs of Bare Lake water were fertilized and the increase of photosynthesis and population measured. The effect of fertilization on the rate of photosynthesis by the existing population in the lake was immediate and large. The rate in the 10-day period after fertilization was increased by a factor of 2.5 to 7 as compared to the 10-day period before fertilization.

The rate of photosynthesis progressively increased after fertilization, then fell to a rather steady level well above the initial value. A second fertilization resulted in a rate greater than the first maximum. Light was supraoptimal, photosynthesis at the surface frequently being about equal to, or less than at 3 meters. The highest efficiencies of utilization of sunlight occurred in periods of relatively low light. Efficiency was increased by fertilization.

Following each of the yearly fertilizations the phytoplankton population increased manyfold, the transparency decreased from about 6 to less than 2 meters and the pH increased from 7.0 to a high of 9.0. Phosphate and nitrate fell to an undetectable level in a few days.

Some rotifers seemed to show an effect of increased food supply in that egg production was apparently accelerated. The planktonic crustaceans did not show a significant increase in population size from 1950 to 1952, possibly as a combined result of their long life cycle and effective predation. Salmon leaving the lake have been longer and heavier in successive years, suggesting that they are responding to increased food supply.

419. Ramaswami, L. S. and Arthur D. Hasler. 1955. HORMONES AND SECONDARY SEX CHARACTERS IN THE MINNOW, HYBORHYNCHUS. Physiological Zoology, Vol. 28, No. 1, January, pp. 62-68.

The eruption of breeding tubercles in the male minnow Hyborhynchus was considered to be a suitable end-point in assaying different pituitary preparations. The females do not develop these tubercles. Unsexed carp pituitary powder, injected in aqueous medium, was found to produce eruption of the tubercles in the male; large specimens in which the tubercles had disappeared after the breeding season developed them with one injection of 0.04 mg. of the powder, the equivalent being taken as 0.07 mg. per 10 gm. of fish. In the medium-sized ones, it required at least four injections administered on alternate days, while in the juveniles five injections brought out the secondary sex character. Pituitary-treated females did not develop the tubercles.

Frog and mammalian (human and sheep) pituitary preparations also produced eruption of the tubercles in males when injected in small doses.

Testosterone propionate produced tubercles in both the male and the female minnows; moreover, the anal papilla was enlarged enormously in the female. This appears to confirm findings of earlier workers that the factors for the development of tubercles are inherently present in the female but the ovarian hormones seem to suppress them. With estrogen (estradiol) the tubercles develop only in the male, and very slight enlargement of the anal region was noticed in both male and female minnows.

420. Clay, C. H. 1955. A PROCEDURE FOR INSTALLATION OF FISHWAYS AT NATURAL OBSTRUCTIONS. The Canadian Fish Culturist, Issue 17, September, pp. 1-12.

The procedure described has been used for the installation of successful fishways at natural obstructions in seven locations in British Columbia to date. The first of these was at Hell's Gate Canyon on the Fraser River, where the now famous fishways were completed 10 years ago. After the problem has been defined as far as possible by biological investigations, the first step is to make an engineering field survey, which should cover topography, hydraulic conditions, and geology. Next, a preliminary cost estimate can be prepared, which will permit consideration of the economics of the project and decision as to whether it should proceed. If the decision is favourable, the preparation of plans can be commenced. Hydraulic and other field data are analyzed in detail and a tentative location for the entrance to the fishway selected. Next, the functional dimensions have to be decided on. The pool size, number of baffles, overall length, and depth of fishway can be rationalized from available data. The structural design can then be proceeded with and finally the detailing and preparation of specifications if required. Important final considerations are the verification or evaluation of the operation of the fishway, and adequate maintenance after completion.

421. Smith, M. W. 1955. CONTROL OF EELS IN A LAKE BY PREVENTING THE ENTRANCE OF THE YOUNG. The Canadian Fish Culturist, Issue 17, September, pp. 13-17.

The American eel, Anguilla rostrata (LeSueur), is often a prominent species of fish, both in respect to

number and size, in lakes of the Maritime Provinces of Canada. Since the eel is a predator on the eastern brook trout and competes with them for a common food supply, control of the numbers of eels in a trout lake is desirable.

The eel is catadromous. Thus, the best long-term measure to reduce and eventually to eliminate eels from a lake is to stop recruitment to the limnetic population from the annual up-stream runs of young eels. In May 1951, as a part of a program to control the predators of trout (fish-eating birds, mammals and fish) at Crecy Lake, New Brunswick, a barrier was erected in the outlet in an attempt to keep out ascending eels (Smith, 1955). The present article describes the barrier and presents observations on the movements and size of eels in relation to it. (A)

422. Atton, F. M. THE RELATIVE EFFECTIVENESS OF NYLON AND COTTON GILL NETS. The Canadian Fish Culturist, Issue 17, September, pp. 18-26.

The relative efficiency and the selectivity of nylon and cotton gill nets was examined in two lakes during both 1951 and 1952 summer seasons. These lakes were Lac la Ronge and Last Mountain Lake.

It was intended in this study to compare nylon with cotton in several respects, i.e., (1) the effectiveness of the two threads when of the same size (2) the effectiveness of nylon when coarser than cotton (3) the effectiveness of nylon considerably finer than the cotton thread. It has been found that such comparisons involving thread size are not possible from our data because of the variety of influences that availability has upon the catch. A critical experiment concerning the effect of thread size would require that mesh size be among the controlled factors. We have not met this condition.

The first conclusion is that nylon gill nets in each mesh size tested, for every species, caught more efficiently than cotton gill nets. The ratio of the total catch in nylon and cotton nets also shows an interesting descending order associated with increasing mesh size. It may be concluded that availability of fish is the chief factor in determining the relative efficiency of nylon and cotton nets. To make the efficiency of nylon nets the same as cotton nets, it is only necessary to choose the appropriate mesh size, i.e. a nylon net of larger mesh size than the cotton.

Ciscoes captured in test nets show that the nylon nets did not take smaller or larger fish than the cotton nets, but only somewhat larger proportions of the same extreme length classes. The mode in every case is the same in the nylon and cotton nets. This is by far the most important feature, and we conclude that the selectivity of nylon and cotton nets shows only slight differences in capturing ciscoes.

As in the catch of ciscoes, the main selective action has been the capture of a greater proportion of whitefish of the larger and smaller size classes also captured by cotton nets. The selectivity of nylon nets is therefore only slightly different from that of cotton nets in respect to this species. The main difference in catch of yellow walleyes was the much greater proportion of 4.5-pound to 7.5-pound fish, though these groups also occurred in the cotton nets. This is the clearest example of selectivity in our data.

In the instances examined, the selectivity of nylon nets is not greatly different from that of cotton nets. Only very few smaller and larger fish are taken, and the main difference observed is a larger proportion of the larger size groups also captured by cotton nets. Differential selectivity of a particular size group of fish may be observed.

In summary, nylon gill nets were consistently more efficient than cotton gill nets in the capture of fish, but the greater efficiency of nylon over cotton gill nets decreased with increasing mesh size. The relative efficiency of nylon to cotton gill nets was determined mainly by the availability of fish. The efficiency of a nylon net may be controlled by choosing the appropriate mesh size, that is, by limiting the availability of fish to the net. Nylon gill nets capture fish of somewhat larger average round weight than those caught by cotton nets of the same mesh size. This is attributed to the elasticity of this synthetic fibre. The selectivity of nylon nets compared to cotton nets varies with the species and with the availability of the size groups in a population. The main selective action of nylon nets is the capture of a greater proportion of the same group of larger fish which are caught also in cotton nets.

423. Schultz, F. H. 1955. FIELD IDENTIFICATION OF ROCKY MOUNTAIN AND COMMON WHITEFISH. The Canadian Fish Culturist, Issue 17, September, pp. 27-31.

The most easily used and distinctive differences are probably (1) the relative length of the anterior and posterior ray of the dorsal fins; (2) the position of the pelvic fin in relation to the dorsal fin; and (3) the difference in the shape between the scales directly behind the dorsal fin.

The difference in the size of the adipose fin can be used to advantage if the posterior end of the fish examined is intact. The ratio of the attached portion of the fin to the free portion in an antero-posterior direction, is one to one for the common whitefish and about three to one for the Rocky Mountain whitefish.

Pigmentation and general body colour are very similar in the two species. However, the presence of black pigment on the fin-membrance of the common whitefish seems to be a distinct and usable feature for identification.

The size of the scales of the two species is generally similar for fish of similar size and age but the difference in shape of scales from the region immediately behind the dorsal fin is a reliable characteristic.

424. Pennak, Robert W. 1955. COMPARATIVE LIMNOLOGY OF EIGHT COLORADO MOUNTAIN LAKES. Univ. of Colorado Studies, Series in Biology, No. 2, July, 75 pp.

Eight northern Colorado mountain lakes (Estes, Copeland, Grand, Manchester, Bear and Brainard Lakes, Beaver Reservoir and Summit Lake) exhibiting a wide variety of ecological conditions were

studied during an entire open season from early spring to late autumn. Of these lakes, the altitudes range from 2277 to 3884 meters; areas, from 1.5 to 205.2 hectares; maximum depths, from 2.4 to 80.8 meters; total residues, from 17.38 to 102.74 mg. per liter. Five lakes are artificial; three are natural.

Maximum summer water temperatures were correlated with altitude. Mean Secchi disc readings ranged from 1.4 to 4.1 meters, and calculated compensation points ranged from 3.0 to 7.4 meters. All chemical, seston, and plankton determinations were made from quantitative samples. As compared with northern Colorado lakes of the plains zone, the following were the chief distinguishing chemical and physical features of the foothills, montane, and alpine lakes: lower temperatures, shorter open seasons, higher Secchi disc readings, lower bound carbon dioxide, less alkaline waters, lower seston, and smaller amounts of dissolved materials.

The eight lakes differed widely in the relative density of their diatom and blue-green phytoplankton. Small populations of Chlorophyceae were found. Twenty-six plankton species of rotifers were identified.

The classification of the eight mountain lakes is evaluated and compared.

425. Bangham, Ralph V. 1955. STUDIES ON FISH PARASITES OF LAKE HURON AND MANITOULIN ISLAND. The American Midland Naturalist, Vol. 53, No. 1, January, pp. 184-194.

This survey of fish parasites was conducted during the summer of 1951 at the South Bay Fisheries Laboratory, Division of Research, Ontario Department of Lands and Forests. A total of 1,667 fish belonging to 53 different species were examined with 98.5 percent being infected. The majority of hosts came from South Bay of Lake Huron with other bays and the open lake and lakes on Manitoulin Island being represented. Diplostomulum spp. were secured from the eyes of 939 hosts belonging to 44 different fish species. Posthodiplostomum minimum cysts were recovered from 411 hosts belonging to 22 different species. Fewer Neascus sp. cysts were encountered than in previous surveys. Echinorhynchus salmonis were recovered from 242 hosts belonging to 23 species of fish. Other species of Acanthocephala were often taken. Triaenophorus crassus cysts were most frequently recovered from the flesh of lake herring from South Bay. Certain Great Lakes bloaters and Mindemoya Lake whitefish also carried T. crassus cysts. Adult T. crassus were recovered only from the intestinal tracts of northern pike. Diphyllobothrium sp. cysts were found in 54 of 79 lake herring and from 26 of 47 Great Lakes bloaters. A few new hosts for parasites are listed for these Lake Huron fish species.

426. Palmer C. Mervin and Thomas E. Maloney. 1954. A NEW COUNTING SLIDE FOR NANNOPLANKTON. American Society of Limnology and Oceanography, Spec. Pub. No. 21, March, 6 pp.

A new counting slide for microplankton has been designed to provide relatively great depth with the "high-dry" objective. It is constructed to hold 0.1 ml. of water sample in a mount shallow enough to allow use of the most common type of 43-45 X ("high-dry") objective. The unit consists of a microscope slide with a disc-shaped chamber having a diameter of 17.9 mm., a depth of 0.4 mm., and two narrow channels through the wall. When covered with a round or square 20-22 mm. No. 1, No. 1 1/2, or No. 2 cover-slip, the disc-shaped area will hold 0.1 ml. of water sample. Two designs of the counting slide have been constructed and are designated as the "ring" model and the "plate" model.

In order to compare the effectiveness and applicability of the Sedgwick-Rafter and Palmer plankton counting slides, a series of parallel counts was made using both slides with the same samples.

The results of this study would indicate that for nannoplankton, the Palmer slide is more satisfactory than the Sedgwick-Rafter slide in determining quantitatively both the number of genera, and the total count of individuals. The higher magnification which may be used with the Palmer slide permits a more positive identification of the organisms, and also makes the smaller organisms, which are missed under the lower magnification, visible and identifiable. The Sedgwick-Rafter slide is still to be recommended where a count of the larger planktonic organisms is being stressed and particularly when they are infrequent in occurrence. In this situation the high magnification is of little importance and the abiltiy to observe a larger volume of sample at one time is more desirable.

427. Kellen, W. R. 1954. A NEW BOTTOM SAMPLER. American Society of Limnology and Oceanography Spec. Pub. No. 22, March, 3 pp.

In an investigation of the insects inhabiting sewage oxidation ponds it was necessary to determine quantitatively the population density of bottom-living chironomid larvae. This created the need for a quick and simple device for taking bottom samples. The bottom sampler described in this article has been used in the field and found to function quite efficiently for the purpose for which it was designed. Undoubtedly this sampler could also be used for bottom sampling under other conditions, and by changing its construction and design, made to fit the specific needs of the investigator.

This sampler samples a 6-inch square to a depth of two inches. Essentially, it consists of a 1 x 2-inch pine wood frame which forms a 6 x 6-inch enclosure. To the inside of the wooded frame are attached four 1/8-inch sheet aluminum flanges. Two of the opposing flanges are stationary and measure 4 x 6 inches. These flanges are bolted to the wooden frame, they extend 2 inches below it. The other two sides are 1/2-inch longer and are hinged at their bases to the wooden frame. These two flanges are made slightly longer to allow for the distance lost when they are brought together and swung through the arc determined by the radius, i.e., the length of the sides. (The distance lost could be decreased by increasing the length of the sides.) The movable sides have sharpened edges and are bent slightly to make them bowed, allowing for better penetrating

and grabbing action when they are drawn together.

The edges of the two movable sides are joined by a short length of wire. This wire is attached to another wire which extends through a 3/4-inch pipe handle fitted to the top of the wooden frame. Thus, by the simple device of wire attachments, the two movable sides can be drawn together, shutter-like, by pulling the central wire. The length of the handle would be determined by the depth of the water in which the sampler is to be used.

In using the sampler in the field, the two movable sides are opened manually and are held in the open position by the pressure exerted by the fixed sides. The sampler is lowered into position until the metal flanges are resting on the bottom. The sampler is then rocked back and forth or worked up and down until the flanges have been forced their full length into the obttom material. They are prevented from going farther by the frame support. When the flanges are in position the central wire is pulled slowly until the movable sides have completely closed. The sampler is then brought to the surface and the sample is removed.

428. Bajkov, Alexander D. 1955. WHITE STURGEON WITH SEVEN ROWS OF SCUTES. Calif. Fish and Game, Vol. 41, No. 4, pp. 347-348.

The primary diagnostic character of the family Acipenseridae is five rows of scutes (bony plates or shields). Out of approximately 7,000 white sturgeon (Acipenser transmontanus) from the Columbia River, about 0.3 percent possessed seven rows of scutes. (J.B.K.)

429. Anonymous. 1954. FARM FISH PONDS IN NEW ZEALAND. Fisheries Lab. Publ., No. 23, New Zealand Marine Dept., 6 pp.

This article presents quite comprehensively the role farm fish ponds may assume in New Zealand, including a resume of overseas practices, farm pond possibilities in New Zealand, inland fisheries policies of the Marine Department, legal restrictions to fish introductions, construction of ponds, water supply requirements, fertilization, and available game fishes. General conclusions are that New Zealand is so abundantly provided with lakes and rivers containing good sporting fish, that development of a pond especially for angling would be an exceptional occurence. Use of such ponds for other recreational needs as well as strict farm requirements would be more common.

430. Wallen, I. E. 1955. SOME LIMNOLOGICAL CONSIDERATIONS IN THE PRODUCTIVITY OF OKLAHOMA FARM PONDS. Jrnl. Wildlife Mgt., Vol. 19, No. 4, pp. 450-462.

Five years of limnological data on 59 ponds in three Oklahoma counties is summarized. The significance of this data is discussed in terms of farm pond management. The interactions of temperature, turbidity, organisms and water chemistry are such as to indicate a need for aquatic plants or fertilizers to add to the alkalinity of the water. Stability of water level through controlled inflow is needed. Clarification of the water has resulted in increased numbers of organisms of greater variety. (A)

431. Chance, Charles J. 1955. UNUSUALLY HIGH RETURNS FROM FISH-TAGGING EXPERIMENTS ON TWO TVA RESERVOIRS. Jrnl. Wildlife Mgt., Vol. 19, No. 4, pp. 500.

Several tagging studies on TVA reservoirs have been reported since 1941. Returns ranged from 0.2 to 29.8 percent. Unusually high returns were recorded in 1950 and 1952 on Watauga and South Holston Reservoirs. One thousand, six hundred and twenty-two fish, mostly largemouth, smallmouth and rock bass, were jaw tagged with No. 3 Monel strap tag in Watauga Reservoir and 662 tags, or 40.8 percent, were recovered by fishermen. In a similar experiment in South Holston Reservoir with the same species, 496 fish were tagged and 204 tags, or 41.1 percent, were recovered. Subsequent fishing apparently was not adversely affected by such high rates of harvesting. (A)

432. Raney, Edward G. and William S. Woolcott. 1955. RACES OF THE STRIPED BASS, ROCCUS SAXATILIS (WALBAUM) IN SOUTHEASTERN UNITED STATES. Jrnl. Wildlife Mgt., Vol. 19, No. 4, pp. 444-450.

It is tentatively concluded that the South Carolina stock of striped bass is an endemic race which in turn is differentiated into an upstream form which may not go to the sea and a downstream form which at least goes downstream to brackish water. Certainly there is little interchange between South Carolina stock and that of Albemarle Sound, North Carolina, or the St. Johns River, Florida. The latter is a good race but its relationships with populations immediately to the north in Georgia rivers are unknown. (A)

433. Ryder, Richard A. 1955. FISH PREDATION BY THE OTTER IN MICHIGAN. Jrnl. Wildlife Mgt., Vol. 19, No. 4, pp. 497-498.

Spring foods were studied from 54 stomachs, nearly half of them from trout waters. Food items are listed in detail. Diet consisted mainly of fishes, crayfishes, and amphibians. Fishes eaten are, in general, of the more available, slower types. Otter may benefit trout by removing competitive species. "On any but the smallest of streams or trout ponds, the depredations of the otter seem to be insignificant even when a maximum population density of otter is attained." Status of otter in Michigan may well be left as it is, with population level of otter interacting with trapping pressure to yield a tolerable balance. (W.H.S.)

434. Martin, Alexander C. 1955. ANOTHER WATERCHESTNUT INFESTATION. Jrnl. Wildlife Mgt., Vol. 19, No. 4, pp. 504-505.

There are now four main areas of Trapa natans infestation in eastern United States. The newly discovered one is in Gunpowder River and Bird River, a few miles east of Baltimore, Maryland, and near upper Chesapeake Bay. The plant and its ecology and the damage it does are described briefly. Early control is essential to avoid huge, costly programs.

"Good results with 2,4-D have been obtained at the rate of 8 pounds per acre of the acid equivalent and with 50 gallons of spray applied per acre. Oil or water solutions are nearly equally effective... Spraying with 2,4-D during two or three successive years can eliminate waterchestnut beds to the extent that remaining scattered plants can be pulled by hand. However, patrol and control may need to be maintained for an indefinite number of additional years in order to avoid loss of all ground gained." The plant is said to be losing ground in Europe; the cause is being sought for possible application here. (W. H. S.)

435. Adams, Lowell. 1955. A PUNCH-CARD BIBLIOGRAPHIC FILE FOR VERTEBRATE ECOLOGISTS. Jrnl. Wildlife Mgt. Vol. 19, No. 4, pp. 472-476.

A punch-card bibliographic file is described from the standpoint of subject classification, cross referencing and cost. The system permits multiple cross referencing with only one card per title. The described card provides for an index to the personal literature file, citation to abstracts, author index, index to the vertebrates, year of publication, and subject index. Nine holes are uncoded for individuals to use in special ways. A code using superimposition allows the individual to establish his own subject-matter classification and to alter it from time to time to suit changing requirements. (A)

436. Gerking, Shelby D. 1955. INFLUENCE OF RATE OF FEEDING ON BODY COMPOSITION AND PROTEIN METABOLISM OF BLUEGILL SUNFISH. Physiological Zoology, Vol. 28, No. 4, Oct., pp. 267-282.

The nutrition of bluegills has been studied to gather information which will relate to fish production. The principal objective of the present work is to describe the influence of the rate of feeding on the body composition and the utilization of protein.

Each of two 30-day experiments was performed on 10 fish in separate laboratory aquaria. The experiments were in agreement. Daily rations of meal worms were fed at rates which varied from 1.16 to 3.59 percent of body weight per day. All results apply to fish of an average weight of 29.7 gm. at an average temperature of 24.6° C.

Considerable change in the body composition was induced by the different rates of feeding. The principal modification was an increase in fat content, which was accompanied by a decrease in moisture content. A relatively small decrease occurred in the percentage protein and ash. Increase in body weight during experiments was shown to be greatly influenced by deposits of fat and therefore could not be used as an indicator of true growth. Changes in protein were considered to represent most nearly the synthesis of new protoplasm.

Nitrogen retention was computed by subtracting the nitrogen content of sample fish at the beginning of the experiment from the nitrogen content of an experimental group at the end of the feeding period. The amount of nitrogen required for maintaining nitrogen equilibrium was 7.2 mg. per day. Above this level, nitrogen was retained in proportion to the amount of nitrogen consumed. The absorption of protein was about 97 percent. The efficiency of protein utilization for growth increases asymptotically to about 32 percent. Maximum efficiency is dependent upon maximum protein consumption.

437. Gerking, Shelby D. 1955. ENDOGENOUS NITROGEN EXCRETION OF BLUEGILL SUNFISH. Physiological Zoology, Vol. 28, No. 4, Oct., pp. 283-289.

The measurement of a maintenance level of protein for the bluegill sunfish was attempted as part of a study of fish nutrition. The fish, varying in size from 10.9 to 168.8 gm., were kept in individual aquaria for 5 days after a 3-day starvation period. Daily injections of dextrose were made directly into the stomach in amounts equal to the metabolic rate. The nitrogenous excretory products accumulated in the water, which was sampled and analyzed for total nitrogen content. Endogenous nitrogen, defined here as the amount of nitrogen excreted by fishes receiving dextrose as an energy source, varied logarithmically with body weight, as it does in higher animals. Considerable individual variation was found, which may be attributed to the handling of the fish and to the fact that their previous nutritional history was not known. Other experiments on feeding fish with an average weight of 29.7 gm. at different rates showed that 7.2 mg. of nitrogen per day were required to maintain nitrogen equilibrium. For fish of the same weight a value of 5.8 mg. per day could be expected on the basis of the present experiments. The close agreement indicates that the method of injecting dextrose was reliable for measuring endogenous nitrogen excretion.

Bluegills excrete about 7 mg. of nitrogen/kg cal, which is three and a half times greater than in homoiothermous animals. This confirms other work on the nitrogen balance of frogs. There may be a fundamental difference in the protein metabolism of homoiothermous and poikilothermous animals.

438. Stroud, Richard H. and Harold Bitzer. 1955. HARVESTS AND MANAGEMENT OF WARM-WATER FISH POPULATIONS IN MASSACHUSETTS' LAKES, PONDS, AND RESERVOIRS. Progressive Fish-Culturist, Vol. 17, No. 2, April, pp. 51-63.

For a study of angler-harvest of Massachusetts warm-water fishes, 12,978 catchable-size largemouth bass, smallmouth bass, chain pickerel, brown bullheads, white perch, and yellow perch were tagged, in 107 ponds comprising about 18,750 surface acres, during the 3-year period between September 1950 and October 1953. Of these fish, 4,829 were native to the ponds where they were caught, tagged, and released; 8,149 were salvaged from water supplies closed to fishing and released in public waters. Recovery of tags was largely by voluntary mailings by anglers. Partial creel census and a reward system prevailed at two ponds. A comparison of returns under these conditions with returns from certain other waters not subject to

these influences indicated that about 75 percent of recovered tags were actually reported. This was applied as an expansion factor to all known returns to estimate harvest. Known recoveries among native fishes amounted to as much as 20 percent of smallmouths, 60 percent of pickerel, 10 percent of bullheads, 5 percent of white perch, and 8 percent of yellow perch. Estimated harvests of native fish by anglers indicate that game fish are cropped about six times as fast as pan fish.

Mortality among salvaged fish was extensive, being estimated to involve at least one-third of all largemouths, smallmouths, white perch, and yellow perch, and about one-half of all pickerel stocked in fall. About one-third of the pickerel stocked in spring may also have died shortly after release. Most bullheads probably survived after release.

In a few ponds estimated harvests of salvaged fish were exceptionally high; namely, 28 percent largemouths, 61 percent smallmouths, 64 percent pickerel, 16 percent bullheads, and 36 percent yellow perch. White perch harvests never seemed to exceed 1 percent. Only 0.7 percent of 1,283 known recoveries had migrated to other waters when caught. The finding invalidates earlier recommendations to screen outlets from ponds, lakes, and reservoirs to prevent loss of catchable warmwater game and pan fish.

Salvage and transfer for purposes other than biologically sound introductions or restocking after reclamation (or equivalent) cannot be justified on a cost basis. Amounts of money corresponding to the "salvage budget" would provide many times as much fishing if invested in reclaiming unbalanced waters and providing permanent access to public waters.

439. Tebo, L. B., Jr. 1955. EFFECTS OF SILTATION, RESULTING FROM IMPROPER LOGGING, ON THE BOTTOM FAUNA OF A SMALL TROUT STREAM IN THE SOUTHERN APPALACHIANS. Progressive Fish-Culturist, Vol. 17, No. 2, April, pp. 64-70.

From 1942 to 1948, a 212-acre watershed on the Coweeta Experimental Forest, Macon County, North Carolina, was logged by a local contractor. Roads and skid trails were built parallel and adjacent to the stream channel. No surfacing material and no drains were used. During storm periods the turbidity of Shope Creek was appreciably increased by the highly turbid waters from the logged area. Sand and silt accumulated in Shope Creek below the mouth of the stream from the logged watershed. Roads and skid trails proved to be the major source of turbidity. From April 1951 to March 1953, an average of 5.34 cubic feet of soil per lineal foot of road surface was eroded from the logging road.

From October 1952 through January 1953, the period of maximum accumulation of sediment in the affected section of Shope Creek, there was a significantly lower standing crop of bottom organisms at the station below the mouth of the logged watershed. A flood on February 21, 1953, removed the accumulation of sand and silt in Shope Creek below the mouth of the logged watershed and reduced the bottom fauna at the lower station to 7.3 organisms per square foot, as compared with 25.5 organisms per square foot at the upper station, which had not been subject to siltation from the logged watershed. The February flood exposed an excellent bottom of rubble and gravel at the lower station; from February through May spring rains and high streamflow prevented the reaccumulation of sand and silt at the lower station on Shope Creek and bottom fauna reached a high of 47.2 organisms per square foot by April 21. During this period there was no significant difference in the standing crop of bottom fauna at the control and treated stations. During June, when silt had begun to reaccumulate, the control section again produced a larger standing crop of bottom organisms. The difference was not statistically significant.

440. Fontenele, Osmar. 1955. INJECTING PITUITARY (HYPOPHYSEAL) HORMONES INTO FISH TO INDUCE SPAWNING. Progressive Fish-Culturist, Vol. 17, No. 2, April, pp. 71-75.

The following method has been used in Brazil only on the species that breed once a year, at the beginning of the wet season, when they leave the dams and pools and go upstream to reproduce. Among these fish are the common curimata, Prochilodus sp. (Characidae, Prochilodinae), piau, Leporinus sp. (Characidae, Anostominae), cangati, Trachycorystes sp. (Doradidae), and curimata pacu, Prochilodus argenteus Spix in Spix and Agassiz (Characidae, Prochilodinae).

Glands are always collected from fish going to market, a few hours after death. It is necessary that the fish used show well-developed gonads, no matter whether they are male or female. Two experienced operators can collect up to 100 pituitary glands in one hour. They are preserved in absolute alcohol in a sealed, dark-colored, 20-cc vial at room temperature. Pituitary glands thus preserved have been used over periods as long as 2 years without showing any loss of their hormone potentiality. Inasmuch as researches conducted by biologists of the Servico de Piscicultura, D. N. O. C. S., Brazil, have proved the nonspecificity (with regard to sex) of the gonad-stimulant hormone taken from fish pituitaries, all glands collected are kept in the same vial.

Doses are prepared from whole ground glands a few minutes before the injection is given the fish, and they are repeated every 6 hours until spawning is obtained. Injections are made intramuscularly, under the scales, by means of a hypodermic syringe with a 30 by 7 needle, at the humeral regions, right and left sides, above the side line, and at right and left sides of the tail peduncle, successively. Spawning usually occurs a few minutes before the injection of the fifth dose, when each male has generally received the total amount of gonadotrophic hormones contained in a pituitary gland of a common curimata, while each female has received one and a half times as much. Artificial fecundation is rarely resorted to, always allowing sufficient time for the spawning to take place naturally in the aquarium.

Extensive experiments are underway to improve

the technique of using injections of pituitary hormones to induce fish to spawn. These experiments are aimed at the use of liquid other than physiological solution, permitting slower absorption and thus reducing number of injections, and use of injections obtained exclusively from the front lobe of the pituitary gland, the objective being to investigate the existence of hormones that may retard the maturation of the gonads.

441. Johnson, Harlan E., Clyde D. Adams and Robert J. McElrath. 1955. A NEW METHOD OF TREATING SALMON EGGS AND FRY WITH MALACHITE GREEN. Progressive Fish-Culturist Vol. 17, No. 2, April, pp. 76-78.

In planning an installation for use at the U. S. Fish-Cultural Station at Spring Creek, Washington, it was decided to use a pump driven by an electric motor to inject a measured quantity of concentrated malachite green solution into the main water supply line before it entered the hatchery and thus to treat all the water then in use. The pump draws malachite green solution from the storage tank and forces the solution either into the by-pass line or through a meter. The meter consists of a tapered glass tube etched with graduations of 10 to 100 percent. The solution passing through the meter raises a metal "float" within the glass tube, and the location of this float in relation to the graduations indicates the flow in percentage of total capacity. The rated maximum capacity of the meter is 2.70 gallons per minute, which is the amount of liquid passing through the tube when the float is at the 100-percent mark. The position of the float is regulated by adjustment of the by-pass needle valve, which, when open, allows part of the solution to return to the storage tank without flowing through the meter. The malachite green solution on the discharge side of the meter passes through a check valve and is injected into the hatchery water supply pipe just past the main control valve.

Where 108 troughs were to be treated, the procedure was as follows: (1) Two pounds of malachite green crystals were dissolved in a pail of warm water and poured into the storage tank, which was then filled with water to the 100-gallon mark. This made a solution of about 1:417. (2) Water flow into each trough was adjusted to 7.5 gallons per minute. (3) Motor and pump were started. By adjustment of the by-pass needle valve, the float in the meter was raised to the 62-percent mark, which indicated a flow of approximately 1.67 gallons per minute through the meter. This made a solution of about 1:203,000 malachite green in the water line and in the troughs. (4) The pump was operated for 60 minutes, during which time 100 gallons of solution were injected into the water line. (5) Pump and meter were flushed with clear water.

Semiweekly treatments were administered to all fall chinook salmon on hand during the egg and fry stages until the fish were ready to start feeding.

Results obtained from treatments with this apparatus at the Spring Creek Station during 1953 were satisfactory. There was little evidence of fungus on eggs or fry, and there was no abnormal mortality that could be attributed to the method of treatment. Visual observations indicated that there was a uniform distribution of the malachite green throughout the hatchery troughs. The cost of the installation was approximately $300 and will soon be repaid in labor savings.

442. Beal, Fred R. 1955. SILVER SALMON (ONCORHYNCHUS KISUTCH) REPRODUCTION IN MONTANA. Progressive Fish-Culturist, Vol. 17, No. 2, April, pp. 79-81.

Silver salmon (Oncorhynchus kisutch) from sea-run stocks have been liberated in certain Montana lakes over the past many years. Plantings have been made most regularly into Georgetown Lake, Granite and Deerlodge Counties, and Crystal Lake, Lincoln County. As this species of fish fills a management niche in certain waters in the State and provides so much recreational fishing for the Montana angler in these waters, concern has arisen over the future supplies of eggs.

There has been no indication that silver salmon planted in Montana lakes have reproduced, even though at least two lakes have inlets used extensively by trout for spawning. The observations reported in this paper were made as the first step in determining feasibility of (1) establishing a source of land-locked silver salmon eggs, and (2) establishing a population of land-locked silver salmon that would reproduce naturally. It has been demonstrated that eggs taken from mature land-locked silver salmon whose parents were of sea-run stocks can be fertilized and hatched, and the resulting fish can be reared in hatcheries. Further, it has been demonstrated that such fish, when held in hatchery brood ponds until maturity, can be spawned and the fertilized eggs will develop and hatch. Loss of eggs to the eyed stage was large, but thereafter losses in fry and fingerling fishes were normal as compared to the losses of other fishes reared in the same hatchery.

443. Wilkins, L. Price. 1955. OBSERVATIONS ON THE FIELD USE OF CRESOL AS A STREAM-SURVEY METHOD. Progressive Fish-Culturist, Vol. 17, No. 2, April, pp. 85-86.

Commercial cresol has been used extensively as a survey method for sampling trout populations in Tennessee streams. It has been very effective for determining the limits of trout water, the presence of reproduction, and the approximate carrying capacity of a stream. At present, cresol is being used to supplement original survey data and to follow the progress of experimental trout releases. It is equally useful for sampling fish populations in small warm-water streams.

The concentration of cresol is rated as to its phenol equivalent as a disinfectant. The highly concentrated phenolic emulsifiable disinfectant (coefficient 30) offers the advantages of efficient recovery and small amount of agent required. The effect of cresol is apparently one of respiratory membrane irritation and depletion of dissolved oxygen. The chemical is usually introduced at a narrow and turbulent point in the stream where

natural mixing action quickly carries it into emulsion. The most economical rate of application must be determined by experience, as stream volume, velocity, turbulence, carbonate hardness, pool area, and temperature all affect the length of stream sampled. However, the general rule of 1 gallon cresol (p.e. 30) per 4 cubic feet a second for 100 yards of stream is useful. The use of cresol is not practical in streams having volume of flow greater than 25 cubic feet per second.

Experimental releases of fin-clipped hatchery trout, 1 hour before introduction of the cresol, have resulted in recovery rates ranging from 72 percent to 95 percent. Cresol can be used successfully at all temperatures, but loss of strength through volatilization is more rapid at higher temperatures. Brown trout are slightly more resistant to the effects of cresol than are the rainbow and brook trout. No appreciable difference in susceptibility of wild and hatchery trout was noted. Approximately 150 wild rainbow and brook trout, collected with cresol and transferred to hatchery ponds, showed no deleterious effects from exposure to the chemical.

444. Brand, D. J. 1954. A COMPARISON BETWEEN THE DIETS OF TILAPIA SPARRMANII AND THE BLUEGILL SUNFISH, LEPOMIS MACROCHIRUS. Dept. of Nature Conservation Rpt. No. 11, Cape Town, South Africa, pp. 55-58.

Bluegill-sunfish were imported in 1938 mainly upon their reputation in the United States of America as a forage fish for use in combination with the largemouth bass (Huro salmoides). Under South African conditions, however, experience has shown that bluegills are almost abnormally prolific. Even when they are only three to four inches long and one year old they can, and do, spawn successfully. The result is over-population in a relatively short period after they have been planted in a water. This leads further to stunted fish of inferior quality.

An investigation of the stomach contents of the indigenous Tilapia sparrmanii and the introduced Lepomis macrochirus indicates that the former is predominantly herbivorous when adult, whereas the latter is carnivorous throughout its life. The practical importance of these facts is that Tilapia sparrmanii can be introduced into the same water as a carnivorous species, such as bass, without involving any appreciable competition for the same types of food or serious predation upon the young of the end-species by the forage-species. Where bluegills are used, it is necessary to make sure that the ponds can be effectively netted or emptied so that the number of fish can be controlled.

445. Younger, Roy R. 1955. HOOK AND SPEAR. New Jersey Outdoors, Vol. 6, No. 3, September, pp. 8-14.

The New Jersey Division of Fish and Game, with the cooperation of the Underwater Fishermen of New Jersey, has undertaken a study of the possibilities of an underwater creel census. Post cards were employed as a census form, since personal contact with the fishermen was not always possible. It was originally intended to compare underwater success with surface water activity in the same areas. However, because of the very low returns from the surface fishermen in this area it has been necessary to incorporate returns from all jetty and inlet fishermen from Sandy Hool to Barnegat Light, which includes sections that are not open to underwater fishermen.

During the period of July to October, 163 skin divers fished a total of 265.3 hours for an average fishing trip of 1.6 hours and caught 108 fish. They reported having seen 15,000 fish. The catch per hour was .407 fish. The surface anglers, for the same period, spent 528.8 hours fishing, with an average trip lasting 5.39 hours. They reported catching 39 fish for .073 fish per hour.

This pilot study has suggested that, presently there is little overlapping in the species of fish harvested by underwater and conventional fishermen, with one notable exception. The striped bass, which is actively sought by both groups, is much more frequently taken by underwater fishermen than surface anglers fishing during the same period. It has already been strongly indicated, however, that this is largely due to improper techniques and a lack of knowledge of the habits of the striper on the part of the conventional angler. The sport of skin diving, whether it be merely to enjoy the beauties of the underwater world, to photograph and observe its varied and colorful life, or, to pursue a fish for reasons as basic as a hunter's, is one that has undoubtedly passed beyond the fad stage. It is here to stay. It demands a place in our varied recreational picture and it most surely deserves it.

446. Fielding, James R. and William P. Baldwin. 1955. EFFECT OF SOME NEW INSECTICIDES ON FISH AND WILDLIFE. The N. C. Agricultural Extension Service, Univ. of N. C. a 16-page pamphlet reprinted from the 1955 Pesticide Handbook.

This paper summarizes the more important studies on toxicity of insecticides. DDT and its effect on birds, fish and mammals is discussed at length. The newer insecticides such as Aldrin, BHC, Chlordane, TDE, Dieldrin, Lindane, Methoxychlor, Parathion, TEPP, Toxaphene are also discussed insofar as their effects on wildlife and fish are known.

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